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The titles included in this collection are: Biographical Research in Health Education; Historical Research as it Applies to Groups or Institutions; Water & Electrolytes and Other Aids; Limiting Factors of Endurance Performance: A Brief Review; Limiting Factors for Endurance Exercise: Carbohydrate and Fat Utilization; Hooked on Running: A Psychobiological Perspective; Psychological Concomitants of Running; The Meaning of Regular Jogging: A Phenomenological Approach; Exercise, Aging, and Psychomotor Performance; Age-Related Changes in Central and Peripheral Processing; Subcellular Aspects of Aging--Training; Bigger, Faster, Stronger--Power Weight Training; Selected Student Characteristics and Learning from a Recreation Resource Management Gaming-Simulation; Land Managers' Perceptions of Risk Recreation in the Northern Rockies; Outdoor Recreation and Special Populations in the State of Utah; Residential Density and Recreational Participation; A Descriptive Answer to the Question of Kinesthetic Imagery; Moving Together in Improvisational Dance: An Empirical Phenomenological Study. References are included with each paper. (DS)

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AAHPER Research Consortium

SYMPOSIUM PAPERS:

HEALTH, FITNESS, RECREATION AND DANCE

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U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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A NOTE TO THE READER

The Symposium Papers (Volume II, Books 1, 2, and 3) are published with one major purpose in mind. The papers are intended to provide the reader with an up-to-date synthesis of research in a wide variety of areas. Presentations were invited from each of the seven associations of AAHPER. Review boards screened Symposium Presentations under the direction of the Research Consortium President-elect. Special attention was given to the quality of the presentations and to the relevance of the research syntheses to the practioners in each of the seven associations.

The Symposium Papers are being made available for sale at the convention at which the actual papers are presented. This is done to make these research syntheses available to Alliance members at the earliest possible time, while the information is current and useful. To do this, it was necessary to make each author responsible for preparing his or her own manuscript. To be eligible for publication authors were required to submit their intent to publish early in the year and submit a manuscript, typed in the proper formate, by February 5, 1979. In cases where authors failed to meet the above listed guidelines, the papers were deleted from this publication.

These Symposium Papers are photographed from original manuscripts submitted by each author. The screening of symposia served as the editing process, once accepted sole responsibility for the content rests with the author(s).

It is hoped that these Symposium Papers are useful to members of all associations of AAHPER.

Richard H. Cox
Editor

David H. Clarke
President-elect
Research Consortium

Note: Because of the length limitation imposed on authors reference lists are necessarily short. In most cases more complete reference lists are available from authors on request.

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Biographical Research in Health Education

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Health education has reached a point in its development as a profession to merit a critical study of its past. In addition to teaching health education students the knowledges and strategies needed to procede forward within the health education field, there is also a need to add depth and perspective to their education by looking backward. In other words, awareness of events, individuals, and philosophies which have preceded the current day health educator will help to contribute to their overall perception of what it is to be a health educator.

Biographical research can contribute to this goal by presenting a realistic and objective account of the accomplishments of individuals as they functioned in their own time and their own setting. As Nevins (1938) has stated, there is a need for biography because it "humanizes the past and enriches personal experiences of the present in a way that history can seldom do." To be able to go back in time and put together in one study the sum total of an individual's impact on a profession is, in my opinion, a meaningful research project. To record dates in chronological order can be a simple enough task, but to bring your subject to life on paper is another matter. Kendall (1965) stated what I think should be the aim of every biographical study, and that is "to elicit from the coldness of paper, the warmth of a life being lived...." There are individuals who have given much to health education, and it would benefit all of us in the profession to have their efforts known and recorded for future reference. Conversely, it would be to our professional deteriment to allow these people to slip into obscurity to be "forgotten or exist only in dry eulogy or brief paragraphs of...textbooks" (Bowen, 1969). The current generation of health educators should have the opportunity to know the individuals behind the chronological listing of accomplishments.

Selecting a Subject

You need to select an individual worthy of being researched. The means by which you decide whether or not this person is worthy is still uncertain. Subjective evaluation by the graduate student and his supervisory committee can be made regarding the individual's total participation in the profession from the local level all the way through to the international level. Whatever method is used, however, it is important that the subject of any biographical research be carefully selected. To do a study on an individual of questionable qualifications belittles the degree as well as the research.

In 1976, a physical education dissertation completed by Carolyn K. Bell at the University of Utah developed a score card for use in evaluating physical education leaders. The score card has nine major units:

1. Age
2. Education
3. Professional Service
4. Professional Organizations
5. Community Service and Organizations
6. Authorship
7. Addresses, Speeches, and Lectures
8. Creative Projects
9. Honors and Awards

Based on applying her score card to 27 completed biographical dissertations, Dr. Bell recommended that a minimum standard of 3,000 points be earned by individuals to merit biographical study. Consideration by the graduate student and his supervisory committee would have to be given to the possibility of an individual earning the majority of points in one, or perhaps two of the nine major units. According to Bell, variety of contribution would need to be as important as volume of production.

I applied Bell's score card to my already completed study of Dr. Delbert Oberteuffer of The Ohio State University (Grosshans, 1975). As is typical of many health educators from the past, Dr. Oberteuffer did not restrict his professional activity solely to health education. Therefore, the score card could be easily adjusted to evaluate his accomplishments in both fields. Dr. Oberteuffer earned approximately 11,200 points. The majority of his points were earned in the following four categories:

1. Addresses, Speeches, and Lectures, 6400 points
2. Professional Service, 1890 points
3. Professional Organizations, 1600 points
4. Authorship, 770 points

One reason for the low score in the authorship category might be due to a possible weakness in the score card. Although Dr. Oberteuffer has had two textbooks which have 11 editions between them, only the two original publications received points. If a book has sufficient demand to warrant numerous editions, then the scoring, appropriately rated, should reflect this merit. Also, I believe a point difference needs to exist for sole authorship and co-authorship of books and articles.

Using this score card, it was obvious that Dr. Oberteuffer's major contributions came in the areas of speaking, service, and professional organizations, with authorship a respectable fourth place. To record these accomplishments, and in Dr. Oberteuffer's case, he kept meticulous records of speeches, would be a matter of listing his addresses, the group he spoke to, the date, and the topic of the presentation. Dr. Oberteuffer also noted the approximate size of the crowd so I could report that he addressed audiences that ranged from as few as 15, to as many as 6400 people. The problem I

encountered was how to present this charismic man on paper as he was known to his friends, students and colleagues, and remain objective.

To solve this problem, I tried to make my study comprehensive by interviewing as many people as possible who knew Dr. Oberteuffer in different capacities. Thus, I gathered information from Dr. Oberteuffer's wife, his brother, several childhood friends and classmates (including former Supreme Court Justice William O. Douglas), former students, former colleagues, old friends, new friends, persons who worked for Dr. Oberteuffer, and persons for whom Dr. Oberteuffer worked. Also, once I got into the actual biography, I did not refer to Dr. Oberteuffer as "the subject of the study." Dr. Oberteuffer was more commonly known among his friends and colleagues as "Obie." Therefore, I used his nickname whenever it fit the situation.

Futhermore, I tried to be realistic when describing Dr. Oberteuffer's life. Realizing that no individual is perfect, I attempted to pull from all my interviews a consensus of opinion regarding Dr. Oberteuffer's professional strengths and weaknesses. Obviously, if the individual has sufficient background to merit a biographical study, positive traits and strengths will surpass negative traits and weaknesses. Nonetheless, recognizing and commenting upon known limitations and/or weaknesses does not detract from the man or the study. It does just the opposite as it demonstrates that your subject was human, you were aware of it, and you recorded the facts in an objective manner.

Criteria for Biographical Research

As any researcher will tell you, your task is to report the facts as you find them. In biographical research, your facts, in many instances, are the opinions of the people interviewed or contacted by letter. To provide the researcher with a set of criteria for evaluating information, historical research has external criticism, internal criticism, and primary and secondary sources.

Primary sources are the original materials, secondary sources are descriptions of primary sources. External criticism refers to the reliability and authenticity of the witnesses. How genuine are the sources? Could the sources be forged or changed by others to pass censor? In other words, is what is stated a reliable and authentic description of what really occurred. The purpose of internal criticism is to determine the relationship of the conception and affirmation of the witnesses to what actually happened. In my dissertation, I adapted the following nine questions by Van Dalen (1964) to determine the internal criticism of my study.

1. Was the position, location, or association of the contributor favorable for observing the conditions he reported?
2. Did emotional stress, age, or health conditions cause the contributor to make faulty observations, or an inaccurate report?
3. Did the contributor report on direct observation, heresay, or borrowed source material?
4. Did the contributor write the document at the time of the observation or weeks or years later?
5. Did the contributor write from carefully prepared notes of observation or from memory?

6. Did the contributor have biases concerning any person, professional body, period of history, old or new teaching methods, educational philosophy, or activity that influenced his writing?
7. Was the objective of the contributor to win the approval of succeeding generations or to please or anatognize some group?
8. Did the contributor contradict himself?
9. Are there accounts by other independent, competent observers that agree with the report of the contributor?

Problems In Biographical Research

There are unique problems associated with biographical research. For instance, some of the limitations of my study were: the possibility that an important source of information was overlooked; the possibility that the memory of the contributor mellowed with the passing of time; the author being unable to interview individuals who could make valuable contributions to the study; and the fact that Dr. Oberteuffer was alive (and still is) at the time of the study may have influenced the responses of some of the contributors.

The review of literature also posed a problem. It necessitated that I look at the method of doing biographical research as opposed to the content closely related to my study. It is readily apparent that if a study were already completed regarding Dr. Oberteuffer's professional achievements, I would not be doing an original research project. As a result of this complication, I centered my review of literature upon the approaches utilized by a variety of persons who had completed biographical dissertations within the areas of health education and physical education. In addition to the questions I had regarding research design for this type of study, I was also curious about such things as how does one divide a life into chapters; how much of an individual's personal life should be revealed and recorded; does one's private life have a significant impact upon his professional life, and should that impact be noted; and, to what extent does the subject, if alive at the time of the study, have control over what appears in the final copy?

I found solving these questions frustrating but challenging. It helped to be able to draw on my own personal interest in biographies as a guide to how I wanted to develop, design, and describe Delbert Oberteuffer on paper. I knew what I liked in a good biography so I tried to duplicate that style in my own dissertation. Also, I referred to several books (Bowen, 1969; Kendall, 1965; Nevins, 1938) that dealt with actually writing a biography.

Another problem, although not so unusual, is the organization and interpretation of the data. How do you begin to put into workable order the tapes, letters, transcripts, photographs, speeches, books, articles, awards, etc., that you have gathered together as a result of your research efforts. Organization is the key. Knowing not only your exact chapter breakdowns, but also the order in which the information in each chapter will be used is extremely important. Then, you can file this information into folders marked by whatever system makes sense to you. Other helpful factors are patience, supportive friends, a room where you can spread everything out and leave it until the study is completed, and perhaps a devoted puppy who is quiet when you need quiet, but who is there when you need a companion for a "clearing your head" walk.

The Fringe Benefits

In retrospect, I can cite several benefits that can be reaped from doing a biographical study, in addition to the usual attainment of advanced knowledge and/or skill culminating in a graduate degree. The foundation of any benefit, however, is your subject. If your individual has been involved in varied professional pursuits, then you, the researcher, have a greater opportunity of coming into contact with an equally varied amount of content, including people from past and present generations in health education. Just being able to sit down and talk with people who have had an impact on the profession gives the researcher a broader, more personal sense of perception of health education. With Dr. Oberteuffer, I was able to come into contact with many noted health educators. In some cases I have continued the associations, while with others, I am pleased to have had the opportunity to meet and interview them.

Also, if your individual was quite a character, then your research would most likely be exciting and revealing. I know that I was never bored with tracing Dr. Oberteuffer's professional achievements. He was not a man to avoid a controversial issue for the sake of peace and contentment. As a result, my interviews were usually replete with stories about confrontations or lively defenses of viewpoints held by Dr. Oberteuffer.

Last, but not least, my study enabled me to become acquainted with Delbert Oberteuffer. Many opinions that I hold regarding health education can be traced to either agreeing or disagreeing with this man. My dissertation subject talked back to me, challenged me, encouraged me, and eventually congratulated me. Not every researcher can say that about the subject of their study.

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Historical Research as it Applies To Groups or Institutions

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Introduction

Historical research in various forms provides the basis for most graduate research design regardless of the subject or discipline from whence it comes. The search of past studies, documents and the thoughts of others provide an integral part of the historical foundation of any quality written work. Historical research procedures and format for group study will be identified and outlined in this paper. The research example to be used will be the thesis entitled A History of Health Care at the Navajo Lutheran Mission, Rock Point, Arizona, 1953-1974.

This study has several unique aspects which will illustrate some of the difficulties that may be encountered in the historical study of groups or institutions and show some of the methods which can be utilized in solving those problems. It is hoped that these illustrations may be applicable to other studies of a similar nature.

Background - Internal Components

In order to begin the study of any group or institution and its success or failure a thorough knowledge of the people and culture involved is needed. Because the Rock Point Mission study dealt with health care delivery among the Navajo Indians a working knowledge of their culture and religion was needed. The aspect of health and well-being is deeply entwined with the Navajo culture and has played a major part in whether or not the Navajo people have accepted the health care providers who have entered their lands.

The Navajo does not make the distinction between religious culture and medicine as we do. For the Navajo these are merely aspects of the same thing. Disease or illness is simply stated as disharmony with the world around us. The sick Navajo regards himself as being out of step with nature (Porvasnik, 1967).

In order to obtain a diagnosis for a particular ailment a person might go to a shaman or hand-trembler. Once the diagnosis is made the shaman recommends which " sing " or ceremony needs to be performed. A singer or medicine man is then contacted who knows the paticular ceremony and a fee for the service is arranged (Adair 1967).

Many groups entering the reservation areas for the purpose of health care delivery have been totally unsuccessful in their efforts because they have ignored these basic principles of health delivery within the Navajo religion and culture. No amount of money, facilities or coercion can make the " white man"s medicine " a success without an understanding of the cultural background around which the program must be planned and implemented. Historical research can identify and define these components to avoid spurious conclusions for the program being studied or used.

Background - External Components

Outside forces impinging on the internal structure of a group or institution come from a variety of sources and also must form a major consideration in historical research. In Navajo health care delivery, federal policy and control played a key role in how health care was delivered to the Indian, both by governmental and evangelical groups.

The federal government was never really certain about the extent of its responibilities for Indian health. Medical care as it existed was only available at several of the larger military outposts before 1850. In 1849 medical care for the Indians went under civilian control with the establishment of the Bureau of Indian Affairs (BIA). By 1877 the BIA medical section was also terminated due to lack of funds. Medical care was then left to any obliging independent agency or doctor in the reservation areas (Tyler, 1973).

Health care remained in this state until 1908 when the Public Health Service surveys showed the severe health problems which existed on the Indian reservations. As a result, Congress allocated funds on an increasing basis for medical service to the Indians.

After several increases in funding and the enlargement of programs, it was realized that Indian health problems required broad education. The Indians had to learn what medical services and facilities could do to help them (Tyler, 1973).

Federal Indian policy also intermeshed with the evangelical missions on the Navajo reservation. Through the recommendations of of the Grant Peace Policy, mission societies were assigned the task of educating the Navajo. Missionary educational efforts were, for the most part, combined with some type of health care delivery because the majority of the Navajo people were suffering the ravages of several epidemics along with limited shelter and very little transportation. Mission societies were responsible for beginning the hospitals at Ganado and Fort Defiance along with several other smaller clinics which have been taken over in subsequent years by the Indian Health Service (Kane, 1972).

These factors all had a direct bearing on the philosophy for the establishment of the Navajo Lutheran Mission and for the way health care was provided to the Navajo by the missionaries. These external factors formed a major portion of the historical framework used to study this particular group. Without careful consideration of such external factors, the reasons for the success or failure of a group or institution become less distinct and may be easily attributed to the wrong reasons. Close scrutiny of these external forces is essential.

Isolation of the Historical Focal Point

In any group historical study the task would become almost unmanageable without limiting the study to a specific time period or group of individuals within the total organizational framework. Such boundaries form the walls which are built on the foundation of background material

In the study of a group, numerous choices of individuals from whom information can be obtained are available. However, individual differences and situations can alter the quality of information which can be obtained. Care must be taken to pick those persons with first-hand knowledge of the situations being studied.

In the Navajo Mission study current mission leaders were contacted and the names and addresses of the living members of the original founding party were obtained along with those individuals who played a significant part in the past health care delivery. These persons, in turn, made suggestions of others who might have pertinent knowledge concerning the mission beginnings and past services.

Documents can provide valuable corroboration of events in group history and should be used whenever they are available. At the Navajo Lutheran Mission only a few documents existed which could be used in the history. No diaries or histories were available to corroborate verbal material. It was necessary to compare interviews to document any questionable material.

Correct historical procures must be followed in detail to overcome these problems in documentaion. Procedures used will vary from study to study, but in all cases a conscientious effort must be made to achieve accuracy and validity for as many facts as possible.

In the Rock Point study, the writer relied on oral histories for the majority of the historical information which was gathered due to the almost complete lack of written records. Interviewees were selected from names suggested in preliminary discussions with the mission leadership. Each interviewee was also selected on the basis of his/her knowledge of the time period in question or his/her direct participation in the events being studied.

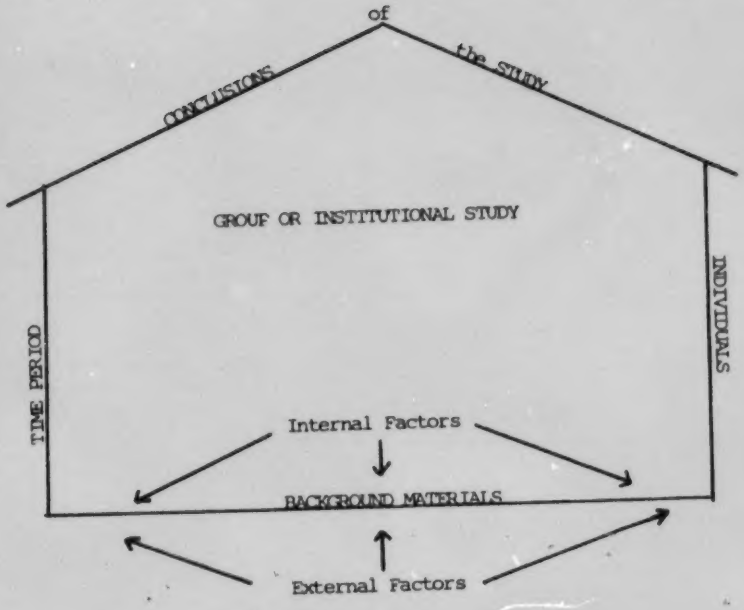
All interviewees were contacted either by telephone or letter in order to explain the purpose of the study and to outline the oral history procedures which would be employed in data gathering. Methods for conducting oral histories which are outlined by Shumway and Hartley (1973) were followed whenever possible.

Interviwees living outside the Utah-Arizona area were contacted by letter to explain the study and to ask permission to interview them by telephone. A specific time and location were chosen for the interview and the individuals were contacted respectively by phone. As a final step the taped interviews were transcribed into typed manuscripts following the format outlined by Shumway (1973).

If oral histories are used as part of any study much of their value can be lost if they are not gathered and used correctly. Oral informationshould be documented whenever possible by eye-witness accounts, pictures or written records. It is recommended that a University history department be consulted for suggestions in setting up an oral history format and that current oral history guides be followed closely when assembling such historical data. Following these procedures will make the conclusions which are drawn later much easier to prove and validate over time.

Impact of Historical Study

The conclusions of historical group or institutional study can be many and varied. In many instances the writer can be creative in his conclusions and leave open-ended suggestions for further research and study. In other cases the value lies simply in discovering the reasons for the success or failure of the group or institution in question. Health program planning would do well to take note of the reasons for successes or failures of other programs and incorporate those valuable methods in their own design. The conclusions, therefore, provide the cap or roof for the group or institutional history model.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Water & Electrolytes And Other Aids

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INTRODUCTION

The most hazardous consequence of prolonged endurance exercise in healthy individuals is the possibility of heat injury. Prospects for this contingency are exacerbated by warm-humid weather conditions in those who have incurred large sweat losses, are less accomplished runners and are used to training in temperate climates. Although the frequency of heat injuries at marathons is low, many participants evidence high body temperatures and water deficits which can deleteriously affect performance and increase the risk of clinical manifestations. Remarkably though, highly successful runners undergo substantial dehydration and tolerate extreme core temperatures in competition (Pugh, Corbett, & Johnson, 1967). A position statement by the American College of Sports Medicine (1975) contains definitive guidelines which specify safe ambient conditions for racing and procedures to guard against dehydration in participants. Although many sports officials have responded favorably to these recommendations, runners have largely failed to drink adequately during the race or to adopt training techniques to avoid exertional dehydration and hyperthermia. What are the limits of sweat loss one can incur without distorting body fluid and electrolyte balances to the extent that performance will be impaired? Can these losses be adequately offset by fluid intake during running so that tolerance to work in the heat can be improved? What evidence is there that differences in factors of training or gender (sex) enable some runners to better withstand dehydration-heat effects during a race? The following discussion is an attempt to address these questions.

SWEAT LOSSES, BODY FLUIDS AND EXERCISE PERFORMANCE

Evaporation of sweat is the principle mechanism for cooling the body during exercise. Unfortunately, the high sweat rates required for heat removal in prolonged running can induce a considerable loss of body water and, to a lesser extent, electrolytes (sweat is hypotonic to body fluids). Although exercise capacity in the normally hydrated individual is limited primarily by the ability to transport and utilize oxygen in the active muscles, dehydration greater than just 2% of body weight can impair physical performance by compromising circulation and thermoregulation (Adolph and Associates, 1947). When water depletion progresses beyond 3% of weight, both heart rate and rectal temperature increase during exercise in proportion to the level of dehydration (Strydom & Holdsworth, 1968; Herbert & Ribisl, 1972) and sweat output may fail to rise with further increments in core temperature (Senay & Christensen, 1965); dehydration beyond 6-10% may cause fainting and even mild work in the heat becomes intolerable (Adolph and Associates, 1947). Dehydration of 3-5% seems to have little influence on oxygen uptake at submaximal or maximal loads (Saltin, 1964a) or upon attainment of maximal cardiac output or heart rate (Saltin & Stenberg, 1964); in contrast, work time at standardized heavy loads and peak blood

lactate levels were sharply reduced, particularly after dehydration by exercise (Saltin, 1964a; Saltin & Stenberg, 1964). Unpublished results from Costill (1976) showed that a diuretic dehydration (4%) reduced VO_2max by 6-7% in running subjects. The upright body position in running may reduce central blood volume, cardiac filling pressure and stroke volume to a greater extent than observed earlier for cycling exercise (Saltin, 1964b) and lead to reduced maximal cardiac output and O_2 transport. Since sweat losses are known to reduce extracellular fluid volumes it has been suggested that muscle water losses may also occur which could suppress cell function and thus largely explain reduced work tolerance after dehydration. In this connection Costill et al. (1976) determined, partly through muscle biopsy studies, that for each percent reduction in body weight due to dehydration, the extracellular and intracellular fluid volumes are reduced by 2.4% and 1.2%, respectively. Furthermore, only small fluctuations in muscle electrolytes were observed after prolonged exercise-dehydration. These results imply that neither muscle membrane potential nor muscle water are substantially affected by sweat losses. Even after repeated days of dehydration, Costill et al. (1975) found that subjects given food and fluid with low K^+ content ad lib incurred no substantial muscle water or muscle ion deficits; in fact, renal mechanisms expanded plasma volume and muscle water and conserved body K^+ stores. Although the often reported finding that dehydration does not reduce muscular strength seems consistent with Costill's observations, there still exists a possibility that dehydration may affect subcellular elements. The physiological mechanisms of dehydration which lead to reduced endurance capacity are complex and not completely explained by the current research evidence. Nevertheless, it is clear that sweat losses beyond 2% can limit the exercise tolerance of distance runners. These effects will be most pronounced when individuals run in the heat at speeds that utilize a high fraction of the aerobic capacity.

FLUID CONSUMPTION IN EXERCISE

Wyndham and Strydom (1969) observed that marathoners who drank during the race to keep their weight deficits below 3%, had final rectal temperatures no higher than 38.9°C, but some who dehydrated more had core temperatures which approached dangerous levels. Since exercising individuals tend to drink less than the equivalent of their sweat losses it would seem advantageous for runners to drink beyond their desire to minimize dehydration. Supporting this contention, Strydom and Holdsworth (1968) demonstrated that water to fully replace sweat losses was more effective than water ad lib in maintaining lower heart rates, lower rectal temperatures and higher sweat rates; ad lib fluid intake, however, did reduce heat strain in comparison to the no fluid condition. Giving water to subjects before exercise in the heat has also improved their heat-work tolerance (Moroff & Bass, 1965). Costill et al. (1970) gave marathoners either water or a glucose-electrolyte (GE) solution in small feedings every 15 minutes during the initial phase of a prolonged treadmill run, finding the two fluids to be equally effective in stabilizing the rectal temperatures during work. Measurements of gastric residue indicated that about 40% of the ingested fluids had been assimilated, an amount representing about one-half of the sweat losses.

If physiological threats to performance associated with large evaporative losses are to be avoided, consideration must be given to optimizing fluid replenishment during exercise. Fordtran and Saltin (1967) showed that gastric emptying was not inhibited when frequent fluid feedings were given in small volumes during vigorous exercise; in comparison with water, absorption of a GE solution (13.5 gm/100 ml) was substantially reduced, although 50 gm of the carbohydrate fuel was made available to the body with GE. Costill and Saltin (1974) examined effects of various fluid characteristics and of exercise intensity on gastric emptying of fluids. Emptying rate was highest with cool fluids (10-20°C) containing little or no glucose, taken in large volumes (600 ml or 20 oz) at exercise intensities $\leq$70% of $\dot{V}O_2max$; extending the exercise to 2 hours and giving 400 ml feedings at 30 minute intervals had no retarding effect on gastric emptying. Coyle et al. (1978) recently compared gastric emptying of commercial GE beverages and water in resting subjects. Fluids were given cold in 400 ml amounts and gastric residue determined 15 minutes after ingestion. About one-half the volumes of water and of the two low carbohydrate drinks (1.1 and 2.5 gm/100 ml) were emptied, but 60 ml less was emptied of the fluid with higher carbohydrate (4.5 gm/100 ml). Collectively, these studies suggest a strategy for distance runners that includes drinking 10-16 oz of a cold, lightly salted (0.1-0.2 gm/100 ml NaCl), low carbohydrate solution within the 30 minutes prior to and at 15-20 minute intervals throughout the race. Thereby, about half the potential water losses may be offset, the body interior may be cooled by heat exchange with the cold drink and unnecessary circulatory-thermoregulatory strain avoided.

TOLERANCE TO DEHYDRATION-WORK: TRAINING AND MALE-FEMALE DIFFERENCES

Robinson (1963) noticed that well trained distance runners exhibited characteristics of heat-work acclimatization, despite not being subjected to high environmental heat during their training. Later observations (Piwonka & Robinson, 1967) confirmed that the heat-work tolerance of trained distance runners could be augmented still further by several days of severe heat exposure with work. Nadel et al. (1974) demonstrated that exercise training results in a higher sweat rate per unit increase in core temperature, while heat acclimatization lowers the core temperature at which sweating begins. Either adaptation will result in an increased sweating response upon presentation of a thermal challenge and will be associated with lower skin and rectal temperatures and reductions in the cutaneous blood flow needed for heat dissipation (Astrand & Rodahl, 1977). Possessing a high aerobic capacity or augmenting this characteristic through training improves heat-work tolerance, since increments in core temperature during work are proportional to the fraction of the aerobic capacity engaged and not the absolute workload. Thus, an individual with a high $\dot{V}O_2max$ can tolerate a faster running speed at a given core temperature than a person with a low $\dot{V}O_2max$. The finding that trained individuals were more tolerant of dehydration during work in the heat (Buskirk et al., 1958) perhaps is due to their ability to keep core temperatures further below a critical point than their less fit counterparts. Heat acclimatization, supplemental to physical training, does not appear to further improve tolerance to dehydration. It should also be mentioned that some individuals, despite repeated exposures to

heat-exercise, cannot acclimate to these conditions, possibly because they are unable to stabilize the plasma volume (Senay & Kok, 1976). Even though high thermal loads (maintained in association with regular daily training) in long distance running improve tolerance to mild exercise in warm conditions, optimal tolerance for vigorous exercise in the heat can only be achieved by training 1-2 weeks in warm environments at speeds near the competitive pace (Astrand & Rodahl, 1977; Gisolfi et al., 1977). Similar adaptations can also be stimulated in a cool environment by training in sweat suits. It is potentially hazardous to do this, however, if fluids are not frequently consumed in adequate amounts to prevent dehydration.

Since females have just recently begun to participate in distance running in significant numbers, it is not surprising that only limited experimentation has been done to delineate the characteristics of their tolerance to dehydration during work in the heat. Weinman et al. (1967) observed that women performed mild exercise in the heat with rectal temperatures similar to those for males, but with lower sweat rates and somewhat different cardiovascular responses suggesting the existance of a sex dependent difference in thermoregulation and a lower heat-exercise tolerance of females. Later research by Dill et al., (1977) showed that sweat rates of females and males were comparable during submaximal and maximal exercise in the desert heat when water was not given; the higher work rates of males under these conditions was related to the males' higher aerobic capacities rather than differences in thermoregulatory capacities. Recent evidence (Drinkwater et al., 1977) suggests that the heat-work tolerance of women distance runners challenged by dehydration is equivalent or superior to that of men; during exercise in the heat (31% $\dot{V}O_2max$) without water replacement the women had lower rectal temperatures and heart rates and higher limb blood flows than revealed in data published by other investigators for males working at nearly the same absolute loads with water replacement. Further research is required to clarify whether male-female differences exist in the capacity for prolonged exercise in environments which induce significant water losses. In particular, studies are needed which compare heat-work responses of highly trained males and females with equal aerobic capacities exercising at levels $\geq$ 70% $\dot{V}O_2max$.

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Limiting Factors of Endurance Performance: A Brief Review

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We are well aware that man can increase his endurance capacity. The adaptations that are responsible for an enhanced endurance performance occur at all levels of the organism. It is easy to measure the endurance capacity of man, but there are limits to how much any one individual can improve. This raises the fundamental question, which step in the regulation or transfer of energy inhibits the organism's endurance capacity? Since a great amount of research has been generated by this question, this symposium will focus on only three possible limitations. These are: 1) sports anemia, 2) heat, water and electrolyte balance and 3) substrate availability. To establish a background for the following presentations, a brief summary of the possible limiting factors of cardiovascular endurance will now be reviewed.

Respiration. There are three aspects of respiration that have been considered as limiting endurance factors. These are; the work of breathing, the limiting factors of flow, and the diffusion capacity of the lungs.

With increasing ventilation during exercise, the energy necessary to overcome flow-resistive work rises rapidly. It has been postulated that at high ventilatory levels the O_2 consumption required by the respiratory muscles may decrease the O_2 availability to the active skeletal muscle and, hence, limit exercise tolerance through increased anaerobic metabolism and lactate production (1). Experiments with "super-maximal" work loads showed that ventilation increased with the work load, but O_2 consumption at the end of the exercise did not increase above the initial maximal level (2). However, Milic-Emili et al. (3) found that at maximal exercise, both in trained and untrained subjects, about 3 to 7% of the $\dot{V}O_2$ max was used by the respiratory muscles. At work loads corresponding to about 75% of $\dot{V}O_2$ max the trained subjects used about 1% of their O_2 uptake for work of breathing. Therefore, the work of breathing is most likely not a limiting factor for exercise under other than extreme conditions.

The weakest link in flow volume was found by Mead and Agostoni (4) to be the expiratory flow. The maximum expiratory flow volume (MEFV) is effort-independent from 70% of the vital capacity and below (5). Further effort, after the MEFV curve has been reached, will result in dynamic compression of the central airways and increase the work of breathing. In normal individuals, however, the MEFV curve is not reached during spontaneous breathing even at maximal exercise (6).

Evidence that the diffusion capacity of the alveoli does not limit performance can be seen by measurements of blood gases during exercise. The arterial O_2 saturation and tension remains fairly constant for increased work intensities (7). The $PaCO_2$ during

exercise is also stable until approximately 70% of $\dot{V}O_2$ max, where after, it begins to fall even though there is a rise in blood lactate (7). It has also been demonstrated that the diffusion capacity of the alveoli increases with increasing work load and does not plateau (6). This is due to an increased and more even distribution of blood flow in the lungs during exercise (8). Therefore, the alveolar ventilation and the time for gas exchange in the lungs appears to be sufficient to maintain normal blood gases during endurance exercise.

Circulation. Assuming that the alveolar diffusion capacity is adequate and the PaO_2 normal, the amount of O_2 delivered to the active tissue is determined by the cardiac output (CO) and blood perfusion capacity of the tissue. To determine if the capacity of the circulatory system to transport O_2 is a limiting factor for endurance performance, both the central and peripheral circulations must be examined. Since $\dot{V}O_2$ max is highly related to endurance performance (9), it seems appropriate to consider whether or not $\dot{V}O_2$ max is limited by the central circulation.

If central circulation is limiting, increased CO or arterial O_2 content should increase O_2 uptake. Conversely, reduced CO or O_2 content should lower the O_2 uptake. An improvement in O_2 uptake and work performance with an increase in partial pressure of O_2 in inspired air was first observed by Hill *et al.* (10) and later confirmed by several authors (11, 12, 13, 14). Similar effects were observed by Wyndham *et al.* (15) with increased ambient air pressure. In addition, researchers (16) have shown that once the $\dot{V}O_2$ max is reached increasing the active muscle mass does not cause an additional increase in the O_2 uptake.

In contrast to the above findings, Doll *et al.* (17) have reported that the PO_2 in the femoral vein during maximal work does not drop below the calculated critical O_2 pressure and concluded that the O_2 supply is not limiting during aerobic work. Using a beta-adrenergic blocker, Åstrand *et al.* (18) reduced CO by 4.5 liters but saw no change in the $\dot{V}O_2$ max. It has also been argued that since maximal values for stroke volume and heart rate are not attained in maximal arm work the central circulation is not a limiting factor (19).

During prolonged heavy exercise CO is rather constant after 10-15 min of exercise. Heart rate, however, increases even after this time with a corresponding reduction in stroke volume. Increased venous pooling of blood and reduced ventricular filling has been suggested as the explanation (20). When brief maximal work is performed after prolonged heavy exercise, however, normal values for stroke volume, heart rate, cardiac output, O_2 consumption are observed (21). Therefore, whether or not the central circulation is limiting for $\dot{V}O_2$ max, it does not appear to be a primary factor limiting prolonged heavy exercise.

Although the capacity of the circulatory system is highly related to the oxidative capacity of the muscle, as indicated by the high correlation between capillarity and oxidative enzyme activity (22), certain factors could possibly reduce blood flow to the active muscle tissue during exercise. As the body temperature rises, blood is diverted to the skin (20, 23). This could reduce blood

flow to the active muscle tissue such that the demand for O_2 exceeds delivery. Reduced muscle blood flow could also be caused by muscle contraction. Folkow et al. (24) found the optimal rhythm for muscle contraction during running and cycling was about 0.3 sec duration contraction/sec. It therefore appears that peripheral circulatory control could be a rate limiting factor in endurance events.

Substrate availability. Carbohydrates play a major role as the fuel necessary for the functioning of muscle tissue during work. Two sources of carbohydrates are available to the muscle during exercise: blood glucose and muscle glycogen.

Levine et al. (25) found in exhausted runners that their blood glucose levels had fallen from 81-103 mg % to 40-50 mg %. This phenomenon was also noted by Christensen and Hansen (26) and later by Guetskow et al. (27). It was proposed that the drop in blood glucose caused exhaustion due to peripheral and/or central nervous system dysfunction.

When working at a submaximal work load, exhaustion is not always accompanied by hypoglycemia. At submaximal work intensities (55% - 85% $\dot{V}O_2$ max) glycogen concentration decreases in a curvilinear fashion with time, the most rapid decline being observed at the onset of exercise (28). At intensities of 65% - 85% $\dot{V}O_2$ max, nearly all glycogen in the muscle is utilized within 1 - 2 hours and this often coincides with exhaustion (29, 30). Several studies have shown that the initial glycogen concentration in the muscle before exercise correlates closely with the maximal work duration at these intensities (31, 32), indicating that the availability of glycogen could be a limiting factor for the ability to perform a prolonged exercise.

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Limiting Factors for Endurance Exercise: Carbohydrate and Fat Utilization

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Muscle, considered as a machine, must convert the chemical energy available in dietary fuels to internal tension. The anatomical design of the body; in turn, allows this tension to be converted to mechanical energy units described as force and work. The stress of endurance exercise poses a unique challenge to the body in that high work rates must be maintained for long periods perhaps with rather limited fuel sources and under less than ideal internal conditions as may occur with dehydration and thermal stress. Nearly two hundred years of research has been conducted in an attempt to describe the relationships that exist between food intake and work output. The purpose of this paper is to (1) summarize our current understanding of carbohydrate and fat utilization during endurance exercise and, (2) to describe how training and diet may alter this pattern of fuel use.

Carbohydrate and Fat Utilization.

The energy produced during work is derived from fuels made available from the storage depots of the body and from that stored within the exercising muscle mass. The liver and adipose tissue function as metabolic energy storage depots.

The muscle itself has only limited capacity to store glucose in the form of glycogen and fatty acids in the form of triglycerides. During work of long duration, these fuels are rapidly depleted and thus there is an extensive use of extramuscular energy supplies.

Adipose tissue stores fatty acids esterified to glycerol in the form of triglyceride (fat). In normal man, this energy represents approximately 90,000 Calories. Despite claims to the contrary, there is no evidence that male-female differences exist in the ability to use the energy for endurance work (Costill et al., 1979). The liver serves a similar function for glucose stored as glycogen and represents about 300 Cal of energy.

As the energy needs of the peripheral tissues increase and/or muscle energy stores decrease the stored energy (as glucose or fatty acids) is mobilized and delivered via the circulation. Uptake and subsequent oxidation of these fuels is increased in relation to the energy requirements as set by the work intensity, availability of oxygen, training status of the individual and selective availability of muscle glycogen and lipid stores.

Blood Glucose.

Pruett (1970) has demonstrated that the levels of blood glucose fall during exercise conducted at moderate work intensities (50-70% VO_2 max). Studies show that an entire marathon can be covered at this pace (Costill & Fox, 1969; Wyndham et al., 1969). Thus the fatigue seen in endurance contests has been attributed to the lowering of blood glucose to hypoglycemic levels (Christensen & Hansen, 1939; Costill & Fox, 1969; Costill, 1972).

However, blood glucose levels per se merely represent a pool into which glucose is constantly being emptied (from the liver) and, from which, it is being removed (by the peripheral tissues). Obviously when these two rates are equal, blood glucose would neither rise nor fall. Studies have shown that both glucose output from the liver (Haltman, 1966,67; Rowell et al, 1965; Wahren et al, 1971) and its uptake by muscle (Chapler & Stainsky, 1968; Costin et al, 1971; Wahren et al, 1971; Young et al, 1967) increase during endurance work. Since liver glycogenolysis and glucose release is closely matched to muscle glucose utilization, blood glucose levels remain relatively constant during steady state exercise until liver glycogen stores become depleted (Baldwin et al, 1973; 1975). Hypoglycemia would occur at the point when liver output can no longer match the continued uptake by peripheral tissues.

Studies of both humans (Haltman, 1971) and rodents (Baldwin, 1973) have shown that the liver can be substantially depleted of its glycogen content following endurance exercise of moderate intensity. In spite increased muscle glucose use and possible lowering of blood glucose during endurance exercise, actual hypoglycemia is rare, though sometimes observed in marathon runners (Costill & Fox, 1969; Costill, 1972; Levine, 1924) and those participating in other very long endurance contests.

These latter observations raise a question as to the relationship between the fatigue reported in these events and blood glucose levels. While low glucose levels may affect the central nervous system (which relies almost exclusively upon this fuel) causing "nervous system fatigue," it is likely that exhaustion in these situations is due to the simultaneous depletion of skeletal muscle glycogen (Bergstrom et al, 1967; Gollnick et al, 1974; Hermansen et al, 1967; Saltin et al, 1971). The relationship between fatigue and low glucose levels, rather than cause and effect, may be coincidental. Periodic ingestion of glucose during work may prevent hypoglycemia.

Muscle Glycogen.

This depot (~1500 Cal) serves as a readily available and immediate source of energy. During the more anaerobic initial stages of exercise in both rodents (Baldwin, 1973) and man (Bergstrom, 1967) this glycogen provides a large portion of the required substrate and is rapidly depleted. As exercise continues, the rate of muscle glycogen use slows while the rate of glucose uptake from the blood increases, so that the requirement for CHO can be maintained.

The rate of glycogen use is dependent upon the relative intensity of the work so that during endurance exercise at 50-80% of maximum, levels approach zero with concomitant exhaustion (Bergstrom et al, 1967; Gollnick et al, 1974; Saltin et al, 1971). These observations have led to the conclusion that the availability of glycogen limits endurance performance. Note that this limitation is in spite of adequate tissue oxygenation and that alternative fuels (lipids) are present For this reason, glucose supplementation, high CHO diet and glycogen sparing protocols have been devised in an attempt to slow the rate, or alter the amount of glycogen used, thus preventing the onset of exhaustion and enhancing endurance performance (Ahlborg & Felig, 1976; Christensen & Hansen, 1939; Consolazio & Johnson, 1972; Costill et al, 1973;

Costill et al, 1978; Ivy et al, 1979; Karlsson & Saltin, 1970; Luyckx et al, 1978; Martin et al, 1978; Rennie et al, 1976). It should be noted, however, that while there is a general relationship between tolerance for endurance exercise and muscle glycogen stores, the relationship is more complex than a direct correlation between total muscle glycogen content and endurance capacity (Costill et al, 1973). Rather, the fatigue observed late in an endurance run is due to a glycogen depletion in the preferentially recruited ST cells (Baldwin et al, 1973; Essen, 1978; Gollnick et al, 1973; Henneman, 1974; Kugelberg & Edstrom, 1968) such that the tension requirement exceeds the capability of these fibers to do continuous work.

Of practical concern for the athlete is the need to have adequate CHO stores to cover the exercise requirement. As indicated earlier, this can be accomplished by dietary means or CHO sparing protocols but is also a natural benefit of training (Astrand, 1967; Baldwin et al, 1975; Issekutz et al, 1966; Karlsson et al, 1974; Short et al, 1969).

Free Fatty Acids.

Both CHO and fat are used for muscular energy during work though the source and relative proportion of these fuels remains enigmatic. The work intensity and duration, and both the dietary and training status of the individual can have profound effects on the source and proportion of metabolic fuel oxidized. Moreover, it has also been shown that the environmental conditions (hot vs cool) will alter the pattern of substrate utilization (Fink et al, 1975; Irondelle & Freund, 1977) towards greater CHO use.

It has generally been observed that during prolonged exercise of moderate intensity there is a progressive increase in plasma free fatty acid concentration. Concomitant with this increase is a reduction in the respiratory exchange (Christensen & Hansen, 1939; Costill et al, 1971; Margaria & Dill, 1934; Paul, 1971). These alterations have been interpreted to mean that there is a change in the carbon source for oxidation from carbohydrate to fat, FFA becoming the fuel source. Uptake of FFA by muscle has been suggested to be in direct proportion to the blood levels (Spitzer & Gold, 1964). Hagenfeldt (Hagenfeldt & Wahren, 1971) has shown that the magnatude of FFA uptake by muscle is related to the amount delivered (i.e. plasma flow X the arterial concentration) and thus is regulated largely by the rate of lipolysis in the adipose tissue. Thus, muscle uptake rises linearly with blood inflow and a saturation of uptake mechanisms apparently does not exist. Animal models of this mechanism (Smith et al, 1977) describe a simple linear self regulation of FFA turnover such that oxidation represents a constant fraction of uptake. This increased uptake is proportional to the concentration and is not due to an increased fractional extraction of FFA from plasma (Ahlborg et al, 1974). Regulation of utilization of FFA by muscle has, therefore, been suggested to be controlled by their availability (Drummond, 1967; Paul & Issekutz, 1967). A commonly accepted extension of these observations is that high venous plasma free fatty acid and glycerol levels during exercise is indicative of both a high rate lipolysis and therefore a high rate of FFA oxidation (Costill et al, 1973) and that the trained individual, by virtue of higher plasma levels during exercise, oxidize proportionately more FFA than the untrained. These observations also serve as the basis for several

CHO sparing protocols whereby the FFA concentration of the blood is elevated prior to endurance exercise (Costill et al, 1978; Ivy et al, 1979; Rennie et al, 1976). Under normal conditions, FFA have been estimated to provide 25-50% of the total substrate utilized (Havel et al, 1963).

Muscle Triglyceride.

Early studies of energy expenditure showed that overall, oxidation of fat accounted for the majority of energy expended during prolonged exercise (Havel et al, 1964; Issekutz et al, 1964) Based on isotopic turnover, however, only a portion of the fat oxidized could be attributed to plasma FFA (Havel et al, 1963; Havel et al, 1964). Issekutz and Paul (1968) hypothesized that the remainder must come from the intramuscular triglyceride stores. Direct evidence in support of this hypothesis has been obtained during studies of triglyceride utilization (Barclay & Stainsby, 1972; Carlson et al, 1971; Costill et al, 1973; Froberg, 1971; Reitman et al, 1973). These data indicate that endogenous lipid use can account for as much as 75% of the fat oxidized (Froberg et al, 1971) and that the greatest use of this fuel occurs in red skeletal muscle (Baldwin et al, 1973; Reitman et al, 1973). Reitman, for example, has found that during endurance swimming, there was nearly a 70% decrease in triglyceride of red muscle, a smaller but significant decrease in intermediate fibers (Soleus) and no change in white fibers. It is likely that these differences reflect recruitment patterns though differences in triglyceride lipase activity may also determine the relative use of triglyceride derived fatty acids (Bass et al, 1969; Bokdawala & George, 1967; Ogata & Mori, 1964).

The time course for the decrease in intracellular triglyceride coincides with the initial rapid depletion of muscle glycogen in the same fibers (Reitman et al, 1973) and Denton has observed that the increase in use of endogenous lipid stores occurs when plasma FFA or glucose levels are low (Denton & Randle, 1967). It has also been shown that addition of exogenous FFA, with or without glucose, to the perfusion media results in a marked reduction in use of endogenous triglyceride in working hearts (Crass, 1972). These data provide support for the concept of a reciprocal relationship between use of endogenous and plasma borne substrates by working muscle.

While the triglyceride concentration in human skeletal muscle is very low (Morgan et al, 1969), it's mobilization would result in a release of glycerol. Assuming that a substantial portion of lipid oxidation during exercise is from muscle triglyceride, this efflux would contribute to the circulating glycerol pool. It is unclear, therefore, why Havel et al (1967) found that the release of glycerol into venous blood draining working muscle in man is insignificant. A possible explaination for the lack of glycerol release in spite of a highly significant rate of triglycerol hydrolysis may be found in the data which suggests that only a portion of the plasma FFA taken up are immediately oxidized (Issekutz et al, 1968; Masoro et al, 1966). The remainder enter an intracellular pool that "recycles" before oxidation (Armstrong et al, 1961; Frederickson & Gordon, 1958; Young et al, 1967), apparently being reesterified (Hagenfeldt & Wahren, 1971) and incorporated into lipid granules (Zierler, 1976). Thus, depending upon the availability of plasma FFA, the relative rate of reesterification vs lipolysis and the metabolic demand, the glycerol released

may or may not be immediately recycled. The significance of these observations cannot be overstated and are perhaps emphasized by considering data from a recent paper (Norris et al, 1978). Prior to a 10 mile run, mobilization of adipose FFA was blocked with nicotinic acid. Compared to a control trial, FFA post exercise were unchanged relative to preexercise values though ketones and blood glycerols were still significantly elevated. Performance was unaffected. The authors speculated that limiting FFA mobilization and use did not deter work since muscle glycogen could have provided the needed energy. Based on the forecited observations, however, it is possible to suggest an alterative conclusion. Since plasma FFA were low, uptake, and the rates of oxidation and/or incorporation into the intracellular "pool" may not have kept pace with the rate of hydrolysis of endogenous lipid stores already present. The glycerol produced would be free to enter the blood. In addition, if the rate of lipolysis and B oxidation exceeded the capacity for oxidation based on the metabolic rate, ketone body production would result, thus accounting for the significant levels of acetoacetate and B hydroxybutyrate which were also observed.

Perhaps more importantly, the forecited studies raise questions concerning interpretation of exercise effects on substrate use and fiber recruitment based on respiratory exchange and/or changes in concentration of muscle lipid and glycogen or plasma levels of FFA and glucose. One can speculate, for example, that the true rate of muscle triglyceride lipolysis remains relatively constant during endurance exercise (at a constant work intensity), but that the concentration decreases initially because the rate of reesterification is slow due to a relative lack of substrate (plasma FFA). Moreover, the commonly accepted view that because plasma FFA levels are high, there is a proportional high rate of oxidation seems no longer tenable (Zierler, 1976).

Integrated Use of CHO and Fat.

During endurance work of moderate intensity, progressively more energy is derived from fat and less from CHO (Ahlborg et al, 1967; Costill et al, 1971). While it is possible to describe a theoretical integrated pattern of fuel supply and use, there are no studies that have actually quantitated the amount of each substrate used in exercising athletes or animals. This is due to methodological limitations.

Upon initiation of work, the endogenous stores of muscle glycogen and triglyceride are rapidly mobilized in the working muscle fibers (Baldwin et al, 1973). The degree of recruitment of fast and slow-twitch motor units would depend upon the relative work intensity and duration (Terjung, 1976) and nature of the work task (Costill et al, 1973; Gollnick et al, 1974) and the fibers basic capacity for tension production by aerobic means (Goldspink et al, 1970).

At workloads commonly associated with prolonged endurance performance (50-80% VO_2 max), the greatest proportion of energy during this initial period appears to be derived from CHO. Histochemical analysis of glycogen content in individual fibers (Kugelberg & Edstrom, 1968) indicates that the ST (Type I) fibers are preferentially recruited (Costill et al, 1973; Essen, 1978).

Reasons for the large initial CHO use are unclear, though may be due to a relative degree of tissue anoxia. Muscle and venous blood lactates obtained during this time support this observation (Costill, 1970; Karlsson, 1971; Keul et al, 1974; Saltin & Karlsson, 1971). As work continues beyond 15-30 min, the sharp initial decline in muscle glycogen and triglyceride is abated and the rates slow (Baldwin et al, 1973; Bergstrom et al, 1967; Saltin et al, 1971). Concurrently, there is a progressive increase in utilization of blood glucose (Wahren et al, 1971) though plasma levels may remain unchanged as liver output has increased to match the greater uptake by muscle (Rowell et al, 1965). FFA mobilization from the adipose tissue depots also is increasing and it has been suggested (Hagenfeldt & Wahren, 1972) that this source then provides the majority of the fuel oxidized. Recent studies, however, suggest that this is not the case. As described by Zierler (1976), it appears that no plasma FFA are oxidized directly. Rather, they are esterified, possibly in sarcoplasmic reticulum and transported as triglyceride to lipid granules near the mitochondria where they are incorporated into lipid granules. Fatty acids released from this source are thus major substrate oxidized. Thus, the concept that during the course of endurance exercise, fuel utilization shifts from endogenous to extra muscular sources may not be strictly true. Also occuring is a progressive shift from CHO use to fat.

The mechanisms responsible for both the observed shift to extra-muscular fuel sources and the relative increase in lipid use are unknown. It can be stated however, that control of substrate metabolism generally encompasses regulation of plasma levels of glucose, FFA, triglycerides, and ketones by extra muscular tissues as well as local control of specific enzyme systems within the working fibers. On the most basic level, muscle has the capacity to oxidize whatever is present to it, including lactate (Baldwin et al, 1978; Issekutz et al, 1976; McGrail et al, 1978; Mole et al, 1978; Poortmans et al, 1978).

Summary.

During prolonged work, lipid provides the major source of muscular energy. It is unlikely that this fuel is limiting for performance. It can be calculated, for example, that even the leanest runner ($\sim$ 4% fat) running at approximately 80% of max for a 2 hr 30 min marathon and using solely fat for energy, would be required to mobilize less than 20% of his body fat. Moreover, claims that female runners are able to "burn more fat," or are "superior" late in endurance contests, are not supported by any scientific evidence. In spite of the major contribution of lipid, CHO availability is suggested to ultimately limit performance. The reason(s) for this effect when alternative fuels and oxygen are present in adequate amounts remains to be elucidated. It can be suggested that some intermediate of glucose catabolism other than acetyl CoA is required for mitochondrial function. As a result of these observations on CHO requirements, endurance athletes are well advised to consume more CHO than in a typical "normal" diet. Periodic ingestion of small amounts of glucose during an endurance contest may prevent the fatigue associated with inadequate CHO levels. Alternatively, the CHO may be "spared" by inducing the cell to use more fat. Training has this benefit

in that not only does the athlete have greater liver and muscle glycogen stores, but also has had cellular adaptations such that relatively more fat and less CHO are used as compared to before training. As a consequence, the athletes' CHO lasts longer, or put another way, he can work harder (run faster) before inducing the same rate of CHO use as the less trained runner.

Dietary manipulations have been suggested to have the same basic effect. The "training" effect combined with a high CHO diet induces greater storage of CHO in both liver and muscle. Ingestion of beverages containing methylxanthines (caffeine) such as tea and coffee prior to, and/or during the endurance contest may enhance use of the bodys' lipid stores. Thus the muscle is "sparing" the CHO and using more fat. The advantages of this include saving the CHO for nervous system use and for late in the run when the athlete may want to "kick." Increasing work intensity in the latter part of the contest increases CHO use. If these stores have been depleted, it is unlikely that pace can be increased.

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Hooked on Running: A Psychobiological Perspective

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We are here to talk about running and the commitment to regular participation in this activity that a surprising number of persons are currently making.

Our nation appears to be in the throes of a running madness. Sporting goods shops report phenomenal sales of running footware and equipment, and a 1977 Gallup poll reports that about 25 million persons (11% of American adults) run or jog regularly. Magazines such as *Runner's World* and *Running Times* proliferate with rapidly rising circulations. Popular periodicals such as *Psychology Today*, *Newsweek* and *Time* frequently include articles dealing with one aspect or another of running or jogging. Books about, and for runners are now on the lists of best sellers.

History reveals that primitive man ran after quarry or from dangerous animals of low order. Obviously, he had no alternatives. And the ancient Greeks used runners to carry messages from one community to another. Understandably, utilitarian factors accounted for man's early engagement in running. But why the apparent fascination with this seemingly unnecessary activity today? No Olympic medal, college scholarship or professional sport contract entices today's running die-hards. None the less, their number is legion.

What is the substance of this running craze? Is it a fad destined for short order expiration like the hoola-hoop? Will its wildfire growth continue until millions more shuffle, dart and scamper along our pathways, roads and city pavements?

Figuratively and metaphorically we have been running for countless decades. We run for political office; run at the mouth; run a business; run a fever; run up a bill; or run around with men or women. But millions of us are now actually carrying out the mechanical, locomotor act of running, and moreover, doing it with high frequency and fervor. Why? What are the dynamics of this rapturous interest in running? Are answers to found in human psychology and physiology?

We plan to address such issues in this symposium through the formal presentation of three papers and through oral dialogue among presenters as well as interaction between them and members of the audience. Our first paper deals with psychophysiological aspects of running. Alleged health and fitness benefits of distance running are examined as are effects such as emotional stress and exertion.

The second paper purports to demonstrate that a theory of addiction is plausible and that regular exercise such as running may produce benefits beyond the cardiorespiratory domain.

Our last paper is concerned with data that portray running as an individual psychological experience with highly personal meaning. Specific ways in which regular running enhances the psychological well-being are also discussed.

Thematically pervasive in the three papers is the hypothesis that a condition known as "running addiction" exists, wherein an individual feels compelled to participate regularly in the running experience.

Psychological Concomitants Of Running

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Approximately ten years ago when exercise enthusiasts were still viewed by the population-at-large as "weirdos," a long-term exercise feasibility study was initiated on a group of middle-aged, sedentary males in Chicago, Illinois (Sime, et al., 1976). This study was conducted by a team of researchers from the Chicago Health Research Foundation with partial funding provided by the Heart Association and the Department of Health, Education and Welfare. At the outset, the purpose of the study was to determine whether this population of "typical" urban American males would comply with chronic behavior changes in habitual physical activity long enough to show improvements in cardiovascular function and reductions in other risk factors associated with coronary heart disease. As with the other risk factors, such as smoking, diet and hypertension, reduction of heart disease incidence could be achieved only with life-long behavior changes. Therefore, the duration of the exercise study was extended to three years under the assumption that the recidivism rate beyond that period would be minimal and that the new habitual physical activity patterns would be nearly permanent. As expected, the cardiovascular efficiency of participants was improved as a result of the thrice-weekly supervised bicycle ergometer training program. Heart rate and blood pressure decreases on the bicycle ergometer testing were obvious early in the program primarily due to the high degree of specificity in training/testing modes. Neither treadmill test results nor blood lipid changes were as remarkable. Of great interest were the adherence rates throughout the three year program. For the 41 participants who started the program in 1968, the adherence at 1, 6, 13, 21, 30 and 36 months was 85%, 71%, 63%, 54%, 48% and 24%, respectively. With only one-half the men remaining at two years and one-fourth of the men remaining active at three years there was little optimism voiced for the feasibility of making large-scale, long-term changes in habitual physical activity. It was apparent that elements in this population or in this mode of training were not conducive to effecting "positive addiction" to presumably health exercise patterns. Furthermore, subsequent research has not produced any conclusive evidence to suggest that physical activity reduces risk of heart disease. In 1971, when this study was terminated, the feasibility and clinical practicality of recommending exercise in the prevention or rehabilitation of coronary heart disease was not merited.

Since 1971, however, there have been numerous changes in the attitudes of Americans toward physical activity. Assessment of recent trends has shown a large increase in popularity of leisure-time exercise pursuits. In the last 2-3 years a jogging craze has hit this country and previously sedentary individuals are pounding the streets and running tracks with renewed enthusiasm. Whether this trend will produce health benefits and, more

importantly, whether it will persist longer than the life of the average American "fad" is not known. A recent 10-year follow-up study on the original 41 middle-aged Chicago males has revealed that at least 39% are currently active, indicating that a positive swing in the attitude of the populus toward exercise has lured some of the dropouts back into an active lifestyle.

The health benefits of physical activity are still not defined, particularly when noting that of the 10 "hard-core" exercisers who remained active at three years in the Chicago study, one had a fatal heart attack at 41 years of age. Two individuals in the dropout population, whose average age was 54 years, experienced non-fatal cardiac complications. The relative risk in epidemiological terms is certainly not favorable toward exercise. Evidence confirming this opinion is noted in the Ontario Cardiac Rehabilitation Study. Preliminary results showed higher re-infarction rates in the high-intensity exercise group than in the low intensity (placebo) exercise group (Rechnitzer, 1978).

In a recent marathon study, 217 runners were assessed by questionnaire following a 26-mile race in Lincoln. Reasons cited for the arduous training and for participation in the exhausting race included: health and fitness benefits, encouragement from friends and relatives, and psychosocial benefits in the form of increased coping capacity and decreased stress and tension. These subjective benefits of exercise are commonly reported, but the mechanisms by which they occur are not clearly understood. Therein lies the basis for another major research endeavor which was recently completed by this author.

Eighty university students were selected from a population of 800 according to self-reported high levels of test anxiety and related symptoms (Sime, 1978). These individuals were randomly assigned to 1 of 5 treatment procedures which included exercise, meditation, combined exercise/meditation, placebo and a control procedure. These treatments were administered acutely prior to an intense "real-life" stressor, a final exam. The results showed that levels of state anxiety and muscle tension (EMG) were significantly reduced in all three of the experimental groups. On the other hand, there were no treatment effects for heart rate or blood pressure. These results indicate that exercise provides some acute relief from excessive muscle tension which is also reflected in reduced subjective feelings of anxiety. These represent very strong motivators for continued involvement in long-term exercise programs because of the specific somatic treatment effects of exercise. Schwartz has suggested that exercise probably is an effective treatment for the somatic element of anxiety, whereas meditation probably is more effective for the cognitive element of anxiety (1978).

One of the crucial issues in physical education is the identification of the peculiar characteristics of the exercise addict vs the exercise dropout. Of great interest is the personal reinforcement history each individual has developed. Are there psychosocial factors such as peer support and parental encouragement which influence behavior? Accepting these as environmental factors, our attention is turned exclusively to biological characteristics of three basic groups of individuals. The exercise

complier who continues in a regime of exercise only as long as it is comfortable and convenient, whereupon he/she may easily become a dropout. Adherers are motivated to stay involved by very positive exercise benefits and lastly, exercise addicts are physically and psychologically dependent upon the effects of exertion.

Baekeland attempted to illustrate the addictive characteristics of runners by depriving them of activity (1972). Restricted runners experienced impaired sleep patterns, and increased sexual tension. These results, together with Glasser's hypothesis (1976) on positive addiction, suggest that physical activity decreases anxiety because of the increased feelings of control, comfort and self-mastery. That exercise addiction has both negative and positive aspects has also been suggested by Morgan (1979). It is possible that exercise is rewarding to those who can tolerate the overload of somatosensory stimulation. To others the stimulation may be aversive. Morgan's negative addiction hypothesis is supported by animal research showing that electrical brain stimulation temporarily blocks the effects of previous aversive experiences (Routtenberg, 1978). In this way exercise may be negatively addictive by the fact that it supresses other aversive sensory input. Withdrawal from exertion causes a rebound effect of hypermotility or cramping which is not unlike that experienced in morphine addiction.

It should be recognized that all of the results cited above were observed in a relatively select population of individuals who seem to be good responders to exercise. In contrast, very large numbers of individuals across society have not had good responses to exercise. In some instances these might be accounted for by poor choice of activity, poor leadership or adverse environmental factors. But for a significant number, there may be inherent physiological reasons why they are exercise intolerant. An analogy to be considered is in the recent evidence on alcoholism. This disease is rare in oriental societies primarily because three fourths of the population experience a cutaneous flush and an allergy-type reaction (though of minimal intensity) after drinking small amounts of alcohol. In contrast, alcoholics are immune to alcohol intolerance and also usually experience a euphoric reaction to alcohol. By analogy, it suggested that addicted exercisers are immune to exercise intolerance and usually experience a euphoric reaction to exercise. It is ironic that non-alcoholics might be protected by a weak allergy-type reaction to alcohol, whereas non-exercisers might be plagued by a weak allergy-type reaction to exertion. Ironically, exercise has been used as an effective replacement therapy for common addictions including alcohol (Guthrie, 1972).

In summary, it appears that attitudes towards exercise, particularly jogging, are improving. Health benefits associated with exercise are not well defined. Psychological benefits in the form of reduced tension and anxiety are apparent. Addiction to exercise is illustrated in both a positive and negative perspective. Exercise tolerance and experience of euphoria may be crucial motivating factors in long-term adherence to physical activity programs.

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The Meaning of Regular Jogging: A Phenomenological Approach

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Why do people jog or run? To the uninitiated, the activity is boring, physically grueling, and time consuming. Yet in spite of such uninviting characteristics, jogging is one of the fastest growing physical activities. Physiologists have produced convincing evidence that running is good for the cardiorespiratory system. It probably retards aging, prevents sudden death, and facilitates weight loss.

Based on the personal accounts of joggers, though, health is not a major factor influencing the great influx of participants. As noted by Dr. Sheehan, runners' guru, "Runners are no longer content with fitness. They are seeking a new awareness of themselves, a self-realization in the total experience of running" (1978, p. 40). Regular jogging seems to result from a quest for physiological benefits such as mood elevation, improved self-image and a sense of accomplishment.

The focus of my presentation is to examine the phenomenological meaning of jogging for the participant by consolidating experimental and anecdotal literature. Four hypotheses generated in an in-depth case study (Berger & MacKenzie, Note 2) will be examined by comparing them to the results of experimental studies and experimental reports of runners. The hypotheses under investigation are that jogging enhances psychological well-being by resulting in a wide spectrum of emotions, by providing opportunity for introspection and thinking, by satisfying psychodynamic needs of the participant and by increasing self-understanding.

The case study by Berger and MacKenzie is one of the few investigations of the running experience itself. The study of a woman jogger was based on two types of data: a personal diary of her thoughts while running during a four month period in which she completed 33 running sessions of 1.8 to 2.7 miles and transcriptions of three 50 minute psychiatric interviews. The interviews were conducted once a week during the last three weeks of the study and were based on the therapist's analysis of the diary material and preceding psychiatric interviews. The data derived from one subject did not reveal the truth for all joggers; however, the four propositions were broad statements which are applicable to a wide variety of people.

Proposition 1. Participation in jogging results in a wide spectrum of emotions ranging from agony to ecstasy.

The woman jogger experienced more than 30 different feelings and emotions which included fright, hostility, hopelessness, loneliness, pleasure, power and resentment (Davitz, 1969). A constantly occurring emotion was guilt. This particular emotion also was observed in the low fitness group of middle-aged exercisers in a Perdue

University fitness program (Ismail & Trachtman, 1973). Noting a rise for novice exercises in Factor O of the 16 Personality Factor Questionnaire, the researchers speculated on causes. "All of the time taken up by the physical fitness program cut into the participants' usual work time and they might have felt guilty because they had been getting behind in their work" (p. 82).

Another emotion expressed repeatedly was the woman jogger's feeling of anger. "I can rub everyone out like superwoman. Zap! Just stay out of my way...It's my secret blow gun, just to wipe people out...Erasing them" (p. 2). Running magazines abound with anecdotal accounts of anger at encroaching automobiles, dogs, and hostile observers. Feelings of anger and hostility directed at environmental obstacles may be a form of displaced anger which the runner prefers not to acknowledge. Experiencing anger during running may serve as an outlet and result in the low aggression and anxiety scores which have been reported by habitual joggers (Clitsome & Kostrabala, 1977; Diensbier, 1977).

Jogging resulted in many positive emotional states such as feelings of aliveness, competency, and power. The woman jogger reported, "Good workout--could hardly breathe for the last 1/2 of the run. When I started out, I really felt strong. Went fast and felt great" (p. 9). Maxie Parks, a male Olympic sprinter reported similar feelings, "You open up in the 400. You attack the ground. ...It's a physical feeling. You feel like you're defeating something that is almost impossible" (Nack, 1976).

Experiencing a wide spectrum of emotions, negative and positive, seems to be a positive benefit of jogging. For the person who values human-ness and feelings, jogging presents an opportunity to augment his or her emotionality. For the person unaware and cut off from many emotions, jogging provides an opportunity to feel and to experience emotions in a relatively non-threatening environment.

Proposition two. Sports such as jogging are conducive to introspective opportunities as well as to thinking in general.

Reflecting on the introspective opportunities in jogging, the woman jogger reported, "When I'm running, it seems like I'm dreaming and a lot of thoughts go through my mind very, very quickly (p. 9). So many joggers have reported similar dream-like states that psychologists have speculated that jogging facilitates right brain rather than left brain functioning. Dienstbier (1977) elaborated on the jogger's opportunities for thinking and introspection, "While running, my thoughts often turn toward the challenges of my work (he is a psychiatrist); I am as likely to be as creative as ever during those times. The list of topics and outline for this article ...were developed while running" (p. 21).

A study of the psychological and physiological characteristics of 48 male joggers between 40 and 59 years of age who ran at least two miles three days a week supported the view of jogging as an opportunity for introspective thinking (Hartung & Farge, 1977). Joggers' high imagination scores indicated that their inner mental lives were intense. Since joggers can engage in free association

while running, it is not surprising that they scored high on imagination.

Regardless of the explanation of the increased creative and dream like states encountered while jogging, attainment of this special way of being seems to entice the jogger to return for more. The nature, scope, and facilitating elements of the participants' altered mental functioning while jogging seems a particularly fruitful area for future investigations.

Proposition three. Engagement in jogging satisfied inner psychodynamic needs.

In order to run for a number of months and years, the participant's personality would have to be congruent with many aspects of the activity. Regardless of the wish for the physiological benefits, a person who is uncomfortable being alone, craves excitement, or enjoys social interaction probably would not remain a jogger.

As indicated by Berger and MacKenzie, two interrelated psychodynamic factors were working to ward off the woman jogger's anxiety. One factor was her obsessive-compulsive characteriological structure; the other was her relationships with her father and brother (p. 10). Extreme obsessive-compulsive behavior is characterized by rigidity, preoccupation with detail, over reliance on intellectuality with a shrinking of affective capacity, and routine activity performed with the use of a schedule (Shapiro, 1965, pp. 23-53).

David Shainberg, a psychologist who runs, also noted his obsessive character, "As I run, I think about a problem. ...As I go over the details of how he did what he did and how I am going to strike back in my way, I note a suspiciously obsessive character to my meanderings" (p. 1005).

A variety of runners have reported the interwoven needs for accomplishment, feelings of power and control (Looney, 1978; Robins, 1978). Bob Anderson, editor and publisher of On the Run, reported that when he first began to jog, he was quite compulsive about it (1978). He lived to run; now that he had matured, he was less compulsive in his jogging and runs to live.

For some runners, participation in the activity is related to personal crises. Them seem to be running away. The woman jogger in the case study first started to run during her pregnancy and explained that she was "anxious and afraid of becoming obese and shapeless" (p. 11). Upon the birth of her child, her anxiety abated and she stopped jogging for two years. She began to run again to contain anxiety related to her marital and professional problems.

Bruce Dern, a 42 year old actor, participated extensively in running for 14 years and said in an interview, "I don't want to be too dramatic, but running may have saved my career, if not my life. It saved my sanity" (Libby, 1977, p. 19). He too experienced difficulty in a marriage and decided on impulse to run--something he had not done since leaving college six years earlier. After running approximately two miles, he found that he could not stop. "I averaged about 10 miles a day. ...I wasn't interested in speed or competition. I just wanted to run" (p. 29).

Anecdotal accounts of runners are endless. Rather than attempt to relate even a portion of them, it seems logical to conclude this third section with the observation that for jogging to be an integral component of a person's lifestyle, it must mesh or preferably augment that person's characteriological structure.

Proposition Four. Awareness of private, phenomenological experiences associated with jogging can be useful for gaining self-understanding.

The possibility of this last psychological result of jogging is highly dependent on the jogger's openness to personal feelings and willingness to explore them. The woman in the case study provided several examples of how jogging had helped her increase self-knowledge. The subject viewed herself as being very competitive and remarked about her dislike of running an unmeasured distance. She observed and questioned, "I just won't know how far I have gone. Being in great competition with myself, I find that greatly distracting. Why do I get caught up in this race with myself? Can I tolerate not knowing how far I've gone" (p. 17)?

Dr. Besson, author of The Complete Woman Runner, viewed running as an opportunity to "know thyself" (1979). I am not sure that all joggers are so fortunate. Since jogging fits within a person's personality constellation, it also may solidify the runner's usual modes of thinking and feeling if the person chooses not to examine his or her feelings, personal interactions, and reactions.

Benjo's (1979) suggestion for maintaining a running log should be enlarged to a diary because access to thoughts and feelings experienced while jogging is an important vehicle for gaining personal insight. The runner's dream like thoughts and feelings are quickly forgotten; the journal provides an opportunity to record some of the material before it is lost forever. Diary entries capture and highlight the jogger's feelings for her own use. Often joggers are unaware of their feelings: the length of time they have existed, their strength, and impact on their lives.

Journal maintenance has been successfully employed in college swimming classes as a way of helping students evaluate some of the psyohological benefits of exercise for themselves and as an inducement for people to incorporate physical activity into their lifestyles (Berger, Note 1). Journal keeping may also be useful to people in other types of physical activities and of different age levels.

Conclusion

The abundant running literature contained numerous anecdotal examples and experimental studies that supported four phenomenological events that occur while running. These experiences may partially explain why joggers report such a wide variety of positive psychological benefits such as a decrease in depression (Brown, Ramirez, & Traub, Note 3; Greist, Klein & Eischens, Note 4). (1) Jogging results in a wide spectrum of emotions ranging from agony to ecstacy. (2) The running session is conducive to introspection as well as to thinking in general. (3) Jogging satisfies specific psychodynamic needs of the participant. (4) Awareness of private, phenomenological experiences associated with jogging is useful to gaining self-understanding.

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Exercise, Aging, and Psychomotor Performance

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The decline of psychomotor responses with age is well documented in simple (SRT) and choice (CRT) reaction time, and other relatively simple tasks requiring information processing. Although aging results in deterioration at several levels of neural organization, central processing has been targeted as more affected than peripheral function. In fact, cognitive tasks with a large psychomotor component that must occur within a time limit are almost universally shown to be slower in aged individuals. Inasmuch as deterioration in physical work capacity of aging individuals has been successfully delayed with exercise programs, an obvious implication is that exercise and its concomitant benefits might also postpone age-related neuromuscular decrements. Several authorities in the area have suggested that cardiovascular status may be related to neuromuscular speed. Whether it is independent of aging or interacts with age is yet undetermined. The general rationale is that exercise contributes beneficently to cerebral circulation integrity in addition to having a trophic influence on the neurons that supply the muscle fibers.

It has been proposed that the functional capacity of the neuromuscular system is higher in trained than in untrained men. Gutman & Hanzelikova (1975) suggest that all trained people are physiologically "younger" than untrained ones in terms of the nervous system. The relationship between exercise, aging, and psychomotor performance, although seemingly a relatively easy one to determine by obtaining measures of psychomotor performance and cardiovascular fitness from the same subjects and correlating them, has not proven to be so simple. A major problem has been the difficulty in obtaining large numbers of psychomotor trials and cardiovascular fitness measures from old individuals. Another obvious obstacle is the enormous amount of time necessary to conduct longitudinal studies of aging humans. The consequence of these difficulties is that most evidence available is from cross sectional studies and is also indirect evidence. Cross sectional studies in aging have been contaminated by a number of flaws. They do not differentiate between age differences and age changes, they are contaminated by selective mortality, they contain a sampling bias resultant from less capable subjects refusing to be tested or to return for testing, and they contain an unknown proportion of subjects undergoing the sudden deterioration that occurs immediately before death. In addition, the effects of differential intrasubject variability and the sex-by-age interaction are unknown in these studies. Almost all suffer from an inadequate number of dependent variable trials administered.

Nevertheless, information from several types of studies may be synthesized to establish a plausible relationship between exercise, aging, and psychomotor performance. These studies may be generally

grouped as those in which a) the psychomotor performance of highly fit groups is compared to low fit groups, b) the psychomotor performance is compared in the same individuals before and after an exercise training program, and c) the psychomotor performance of cardiovascular diseased persons is analyzed. The results of each of these groups of studies will be reviewed and potential mechanisms producing the relationship will be suggested.

Psychomotor Performance and Exercise. Significantly faster neuromuscular responses of highly conditioned individuals when compared to unconditioned individuals suggests a relationship between exercise and neuromuscular response speed. Certainly evidence that highly fit individuals are fast reactors and that cardiovascular training regimes and weight training programs decrease response latency, (albeit by different mechanisms) provides a basis for predicting that persons who exercise might maintain neuromuscular response speed throughout the aging process.

Several studies bear upon the relationship between RT and differential levels of fitness, unfortunately all suffer major flaws and inadequacies. Botwinick & Thompson (1968) for example represent a group of studies in which the RTs of athletes are shown to be faster than nonathletes. They assumed that athletes are more highly conditioned and therefore reaction time might be more related to the cardiovascular efficiency of these individuals than to age. At least eleven studies of athlete-nonathlete comparisons can be assembled and all report faster times on the first day of testing. They don't support the fast-response-high-fitness relationship hypothesis very well however because the genetic profile of the athletes probably includes many speed factors that are more salient than the conditioning factor. Samples composed of athletes probably contain individuals who have become athletes because fast RT, among other variables, has been one of several factors contributing to their success as an athlete.

A somewhat stronger case may be made by those studies where the highly conditioned groups were comprised of subjects who were not athletes. Several investigators have found an age x physical activity interaction, in which a group of sedentary older men were significantly slower, than active old men and analogous young groups. Old running and racket sports groups were dramatically superior to the nonactive group of their age, and also significantly superior to the young nonactive group on both RT and MT, but not significantly different from each other. Another dimension of performance, variability, was also examined. Substantial within-subject and within-group variability was not present in the two active groups, whereas the old inactive group displayed both of these characteristics that are so often cited as an age effect. Regular exercisers have also been shown to score higher on a mental decrement test. The relationship between exercise groups and neuromuscular speed is not, however, unanimously supported. Botwinick & Storandt (1974) reported this relationship existed only for their young groups, not for the old groups. They directly refuted the relationship of exercise to RT, and contradicted Botwinick & Thompson (1968). All of these studies suffer from the assumption that individuals who claim to exercise for specified durations of time per week are in fact highly conditioned. Cardiovascular fitness was not directly measured. The Botwinick & Storandt (1974) study is the weakest in

this respect because the criteria established to identify the high exercise group were not very demanding.

Training and Psychomotor Performance. Support for a relationship between exercise and neuromuscular response speed could also be generated by showing that neuromuscular reponses can be altered by cardiovascular conditioning and/or weight training, and several investigators have attempted this. Simple RT has been shown to improve after six weeks of aerobic training or weight training and SRT, total body RT, and reflex time have all improved following weight training programs. No differences have been found in total reflex time or its components in old and young subjects who vary in activity level. Although the results from the studies reporting changes in RT with training would seem promising in terms of an exercise RT relationship, the results must be interpreted very cautiously because they were derived from RT measures obtained in one day only. It is well established that RT decreases over test days, thus all RT and training studies to date have not controlled adequately for learning effects.

Cardiovascular Disease (CVD) and Psychomotor Performance. Age and/or disease related deterioration of the cardiovascular system, such as occurs in artereosclerosis and heart disease reduces cerebral blood flow. Cerebral oxygen consumption also is decreased and cerebral resistance increased in older persons. In addition, cardiovascular disorders, degenerative anthropathies, and atherosclerotic changes of the great vessels of the neck--all of which have detrimental effects upon cerebral circulation--are found more and more frequently in older age groups. The hypothesis is that cerebral circulatory insufficiency, hypoxia, or hypertension leads to secondary tissue damage, a reduction in metabolic rate, neuronal degeneration and finally to a decrease in cognitive and psychomotor function. The hypothesis is not unanimously accepted, as some researchers believe that this hypothesis has been greatly overemphasized as a cause of memory and learning loss. It should be noted, however, that those who are failing to find relationships between cardiovascular parameters and intellectual functioning in the aged are dealing with the constructs of memory, reasoning, and pathological states such as senile dementia, in contrast to those who are dealing with time-limited cognitive functioning. Certainly brain activity is influenced in some way be cerebral circulation, as evidenced by the many studies showing EEG changes paralleling deficient cerebral circulation and oxygen consumption. Given the dependence of brain integrity on cardiovascular integrity, it is not surprising to find a host of scientists reporting that persons with cardiovascular disease or hypertension also have slower motor responses to environmental stimuli.

The report of Hicks and Birren (1970) is representative of approximately nine studies in which it is shown that persons with cardiac insufficiency have slower RT. In these studies, slowed RT seemed to be independent of age, suggesting that declines of RT with age in cross-sectional studies primarily reflect increasing proportions of cardiovascular diseased subjects in the older segments of the samples. Fast reaction to stimuli may also be a function of an age by CVD interaction, as both visual and auditory SRT were slower in older brain diseased individuals than in young brain diseased persons. Older brain diseased individual SRT's were 66-84 msec. longer than young normals, whereas young brain diseased individuals were only 22 msec. slower.

Other psychomotor task decrements also seem to be associated with CVD and/or hypertension. Tapping speed, where one digit is tapped in one place as rapidly as possible was slower in hypertensive and CVD patients, and decreased more rapidly throughout the tapping trials than the performance of normals. Tapping speed has been used to reflect functional integrity of motor centers. In general, any task with a substantial psychomotor component, time limits, and complex nonverbal material is likely to produce poorer times for persons with hypertension. This psychomotor slowing has also been extended to persons predisposed to CVD, such as Type A personality individuals who had not yet been diagnosed as CVD patients. In many of these studies, perceptual activity, reaction latency, and movement speed are ambiguously defined and perhaps combined. Other factors such as state anxiety and instructional set vary from study to study, so that the specific focus of neuromuscular slowing is unclear. What seems evident, however, is that cognitive decision making requiring rapid response execution is slower in CVD and hypertense subjects. Even such cognitive functions as memory and intelligence have been reported to be more deteriorated in aging CVD and hypertense individuals than in normals. Individuals with excessive diastolic blood pressure declined more in ten years on their Weschler Adult Intelligence Scale score than those with lower or normal blood pressures.

The CVD brain function relationship, when viewed in parallel with the observation that dramatic differences exist in individuals' patterns of decline, have led more than one student of the topic to suggest that neuromuscular responses may be more highly related to health than to age.

Plausible Mechanisms Relating Exercise to Psychomotor Performance. The relationship between exercise and psychomotor efficiency has strong support, albeit indirect support, but what are the mechanisms by which chronic exercise might postpone neuromuscular decline? Two areas which immediately present themselves are the supportive effect of exercise on cardiovascular integrity, and the beneficial effect that exercise might have on central nervous system function.

It is well known that exercise plays a substantial role in maintaining cardiovascular efficiency. A systematic exercise program cannot prevent genetically determined cardiac disease or essential hypertension, or atherosclerosis produced by dietary abuses, but it also is certainly not supportive of these conditions and is very beneficial in the control of nonessential hypertension.

Exercise may also contribute indirectly to reducing the accumulated effects of increased blood pressure and higher serum lipid concentrations by contributing to weight control. To the extent that chronic exercise prevents or controls conditions leading to circulatory insufficiency it also assists in delaying the onset of psychomotor deterioration. Cerebral circulation, normally a remarkably sustained system throughout physical work and all manner of stresses, nevertheless begins to decline in the aging process and is targeted as a cause for age related brain deterioration. It is suggested that one of the reasons the substantia nigra and caudate nucleus (basal ganglia areas involved in the initiation of rapid movement) selectively degenerate earlier with aging is that these areas are highly vascularized.

The effect that exercise has on central nervous system function is not very well known and is in fact almost an unresearched area.

Muscles have a trophic influence on the nerves that innervate them and upon other immediate central connections, but the influence of muscular activity on higher nervous centers, such as the reticular activating system and the basal ganglia is largely unknown. Long ago an "overuse" principle of nerve cells was postulated in which cell aging is influenced to a large degree by the amount of activity in which the cell is involved. Later studies have corroborated this by showing that the decline in transmitter synthesis and speed of muscular contraction that commonly occur in aging does not occur in the diaphragm muscle and in the respiratory muscles that contract aerobically and consistently throughout the lifetime.

The effect that training has on transmitter substances is also unknown. Psychomotor performance is dependent upon efficient synaptic transmission in the mobilization of elaborate neuronal networks in many areas of the brain. Movement initiation may be mediated to a large degree by catecholamine systems, particularly the dopaminergic system; yet these systems are also the most vulnerable to aging. Continued synaptic activity (movement activity) may be necessary to ensure that the synapses involved in movement initiation a) release enough transmitter substance, b) snythesize and store enough transmitter substance, c) provide enough binding sites at the postsynaptic terminals to facilitate transmission, and d) alter transmitter turnover rate. Acetylcholine concentration in the ascending reticular system, cortex, and thalamic nuclei have been related to some aspects of arousal, which certainly influences psychomotor performance.

There has been much progress in recent years in relating behavior to the amount and function of transmitter substances and their precursors. It is probable that future research will reveal that adaptation effects of chronic exercise training include optimum levels and turnover rate of catecholamines, efficient functioning of monaminergic neurons, and an optimum balance between transmitter systems that regulate brain function. Moreover, these effects probably take on increasing importance with each decade of aging. As the evidence accumulates, exercise is becoming a strong candidate as a contributor to a general regulatory mechanism for high quality cognitive function.

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*In the interest of space, almost all references have been omitted. A complete reference list may be obtained upon request, when accompained by a large self-addressed, stamped (67¢ approximately) envelope.

Age-Related Changes in Central And Peripheral Processing

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A frequent finding is aging research is that later life is associated with slow responding. This phenomenon is clearly evident in a number of cross-sectional studies showing a systematic decline in both the reaction to a stimulus and the subsequent movement. The net effect of this decline can be readily observed in the manner elderly execute their movements. Movements with fixed time limits for completion and/or high demands for processing of movement related information require compensation for any slowing in information processing, decision making, or movement speed. This compensation can result in qualitative changes in the movement, and under certain circumstances and outright inability to perform the task successfully.

The observation that declines in processing speed occur at both peripheral and central levels of the nervous system has lead Birren (1974) to conclude that aging results in a generalized decrease in neural pace. A corollary to this position is that the more complex the behavior and the higher (and more complex and interactive) the level of the nervous system involved, the greater the slowness with age. While the age-related decrement is generally reported to be greater when the relative demands for central over peripheral processing are high, manipulation of central processing load has produced equivoacl results. Furthermore, the general concept requires qualification to account for observations of independence in the rate of decline and venerability to slowing evidenced in various levels of the nervous system.

Age-related slowing in the peripheral nervous system has been well documented using a variety of techniques. Declines from early to late adulthood in the maximum conduction velocties have been observed to reach 30% for sensory and 15% for motor nerves (LaFratta & Canestrari, 1968). If systemic, these changes in peripheral nerve function would provide an attractive explanation for some of the observed age differences in perceptual speed. Flickering light, for example, is regarded as continuous light at lower frequencies by older subjects (Critical Flicker Fusion Threshold) (Huntington & Simonson, 1965). This suggests that the neural events may not be quick enough to allow discrimination of the series of events. Also, in tasks where the stimulus and movement complexity are low and the task is highly practiced, reaction times (RT) remain higher for older subjects (Botwinick & Thompson, 1968).

While it may be argued that these phenomena do not preclude a central effect, several studies provide more definitive evidence. According to Turvey (1973), in the monocular backward visual mask-

ing paradigm used by Kline and Szafran (1975), the masking effect occurred at a peripheral level. In this study the critical interstimulus interval occurring between a stimulus and visual noise must be longer for older subjects to perceive the stimulus. Under these conditions, e.g., monocular viewing and the energy of the visual noise > stimulus, masking occurs because the visual noise distorts or absorbs the stimulus before it reaches the central processor.

In spite of the fact that age-related declines have been reported for maximal conduction velocities of peripheral nerves, Clarkson (1978) recently failed to find any age differences in patellar reflex times. Additionally, as reported earlier the decline in maximum conduction velocity of sensory nerves is nearly 50% greater than that of motor nerves. These studies indicate that within the peripheral nervous system there may be wide variation in vulnerbility to aging and in the rate with which any age-related declines occur.

The contemporary opinion (Birren, 1974) is that age differences in sequential motor skills are particularly evident at points with high information processing demands, a finding attributed to large age differences in central processing. As the ensuing discussion will indicate, it is hard to deny the importance of age differences in central processing. However, when motor tasks require rapid and continuous processing of proprioceptive and extroceptive input, peripheral slowing may well play a significant role.

In relative magnitude, by far the larger portion of age differences in reaction time can be attributed to slowing in the central decision mechanism. The fractionated simple RT data presented by Weiss (1965) indicates that differences in premotor time accounts for 70 - 80% of the observed age difference. Additionally, estimates of age differences in nerve conduction velocity and spinal delays indicate they account for only a small fraction of premotor times.

More direct evidence of age-related slowing in central processing comes from studies of dichoptic backwards visual masking (Walsh, 1976). As a group older subjects require a 24% longer interstimulus interval than young adults. In this paradigm visual stimuli were presented to one eye and a mask of similar figural characteristics was presented after a brief delay to the other eye. Masking in this situation occurs at a central location receiving feature specific input from both the right and left eyes (Turvey, 1973).

Several investigators have demonstrated an association between age-related slowing in central processing and changes in electro-cortical potentials such as CNV's and EEG alpha waves. Typically, when a warning signal is presented prior to the stimulus in reaction time tasks, a slow negative shift (CNV - contingent negative variation) occurs in surface cortical potentials. It has been demonstrated that the amplitude of the CNV just prior to the stimulus reflects the subjects anticipatory response or preparatory set. According to Loveless and Sanford (1974) older subjects fail to evidence this anticipatory set if the foreperiod

is long, a condition under which they perform poorly.

Surwillo (1963) has suggested that the tendency for older subjects to show lowered EEG alpha wave frequencies reflects a decline in the basic tempo of the nervous system. In several studies he found correlations ranging from r=.72 to r=.81 between alpha half wave times and reaction times. More recently Woodruff (1972) demonstrated that biofeedback techniques could reverse the drift towards lower frequencies of alpha waves in old subjects and that this resulted in faster reaction times. While her correlation between response speed and alpha frequency was significant, the data suggest that most of the variance attributable to the relationship between age and reaction time is unexplained by the change in alpha wave frequency per se. Never-the-less it does show a linking of response speed with neural activity.

Although these investigations leave little doubt that central processing time increases with age, the nature of the decline remains a point of contention. Evidence is available supporting an accelerating decrement as decision uncertainty increases (Birren & Botwinick, 1955). Other investigators have failed to find any age differences in the slope of response latency by information load regression lines (Crossman & Szafran, 1956).

In addition to the reaction time studies, central processing of information has been implicated in studies where movement precision and thus error correction is required during the movement itself (Welford, 1968). Under these conditions, the movement times of older subjects are differentially increased. This phenomenon is attributed to an age-related increase in the time necessary to evaluate and act on information regarding movement accuracy rather than a decline in speed of movement per se (Tolin & Simon, 1968). As indicated earlier, age-related slowing in peripheral mechanisms undoubtedly plays a role as well.

While age differences in response speed have been vigorously studied, little attention has been given to the possibility that qualitative changes in cnetral processing mediate changes in the pattern or strategy underlying motor performance. It is suggested that evaluation of these mediators or performance changes may be important and that speed parameters may, in some case, merely be the consequence of these changes.

Recently, Klapp (1975) has shown how young adults adapt to increases in movement precision or complexity. Increasing the precision demands of long movements results in longer movement latencies, apparently due to increased feedback control. In short precise movements which preclude the use of feedback, reaction times increase. Ostensibly, this reflects response selection or programming prior to movement initiation. In contrast, Griew (1959) has observed longer reaction times as task complexity increased in his older subjects. In this case, it appears that the older subjects rely on increased preprogramming, possibly in compensation for a declining ability to use feedback control.

Mulligan (1974) provides another example of where older

subjects appear to adopt a more preprogrammed strategy than their younger counterparts. In his study, the RT versus MT correlation for the control condition were essentially zero for both young and old groups. However, when retested in an alcohol impaired condition the correlation for the older subjects, but not the young, jumped to r=.64. Not coincidently, the increase in RT was significantly greater in the older subjects in the experimental condition. According to Laszlo and Liversey (1977) moderate to high correlations occur in conditions where the number of error corrections during the movement is low, i.e., situations where a substantial amount of preprogramming has occurred during the RT phase.

Age-related changes have been observed in several parameters which may be associated with changes in movement planning. There appears to be a re-emmergence of primitive reflexes in the elderly which may reflect a decrease in cerebral inhibitory control (Paulson & Gottlieb, 1968). The consequence of this, and the increased behavioral rigidity reported by Shaie (1955), may well be related to a decline in adaptive control and the necessity to use compensatory strategies. Additionally, in a somewhat related vein, aging has been associated with changes in two cognitive style dimension: reflectivity/impulsivity and field dependence/independence. As a group older individuals tend to become more impulsive (Coyne, Whitbourne & Glenvich, 1978) and field dependent (Markus, 1971). In children and young adults these predispositions are associated with inferior performance on tasks requiring adaptive control or increased reliance on preprogramming.

Finally, it should be noted that frequently performed activities appear to be less effected by aging. While the evidence in this area is not overwhelming, it certainly warrants consideration. Murrell, Paucsland & Forsaith (1962) have demonstrated that industrial workers who frequently perform rapid aimed movements, showed no decrement in performance with age. In contrast, comparison of young and old with no related experience revealed the "typical" age effect. Spirudso and Clifford (1978) found the choice reaction times of old physically active-runners to be inferior to old physically active-racketsport participants. This suggests that specificity of function plays and important role. Additional support of this point has been reported by Clarkson (1978) who failed to find any evidence of age-related declines in the stretch reflex latencies even though others demonstrated declines in peripheral nerve velocities. As she indicates, the frequent involuntary use of the reflexes in postural adjustments may have contributed to the retention of speed in older subjects.

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Subcellular Aspects of Aging-Training

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Physical activity for the aging population usually has been viewed as beneficial. This view is based on the concept that (1) physical activity results in positive adaptations within the organism, (2) aging results in decrements, and (3) aging and physical activity combined result in a lesser "rate of aging" (see Figure 1).

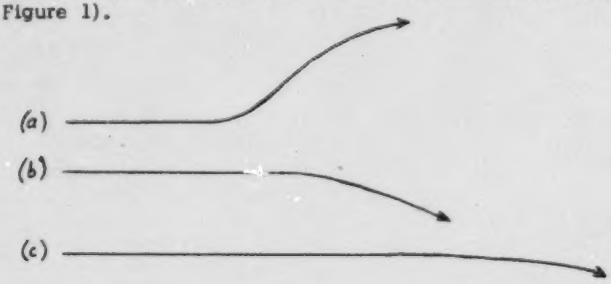

Figure 1. Expected variation due to (a) physical activity, (b) aging, and (c) aging and training.

The biological adaptations resulting from aging-training depend upon the age-at-initiation of the training program. The details of the age-at-initiation of a training intervention program are currently the subject of extensive research. Hopefully, within the next ten years we will have sufficient data to unequivocally answer this very important question. The illustration in Figure 2 indicates the general lifetime variation of specific physiological functions.

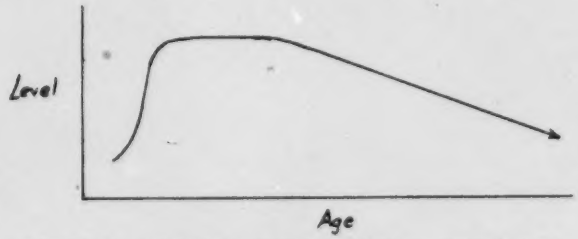

Figure 2. Expected response during growth and development, maturation, adulthood, and aging.

During the growth and development phase there is a general increase in function towards a maximum in early adulthood. Sometime thereafter there occurs what we have labeled a "Threshold Age" (Edington, et al., 1972) beyond which there occurs an age-related decline in function (Bafitis, 1977). This age related decline is widespread and includes such measures as muscle strength, maximum oxygen uptake, brain weight and cellular enzyme concentrations. Most of us are all too aware that body weight does not follow the rate as indicated in Figure 2.

My purpose in this symposium is to discuss primarily the subcellular effects of aging and training in post threshold populations and to indicate future areas of research direction.

It is well documented (although not extensively) in the literature that physical training is effective in altering various components of the body in the aged. Several early review articles by Gore (1972), Astrand (1968), and Shock (1970) have listed aging-training effects in humans. Other review articles (Hodgson and Buskirk, 1978) and (Dehn and Bruce, 1972) indicate that while the maximum oxygen uptake decreases with age (0.28-0.94 ml/kg/min/year) a training intervention program can be utilized to lessen this annual decrement. The large variation in reported decrements were derived due to the use of cross sectional studies versus longitudinal data. The longitudinal data usually result in higher decrements which is attributed to measuring the fall in an individual rather than assessing survivors. Dehn and Bruce (1972) indicated that sedentary men experience a threefold greater decline in oxygen uptake than do persons habitually participating in physical activity.

Astrand (1968), Bottiger (1971), and Drinkwater, et al., (1975) indicate that the age related values for oxygen uptake show an increase up until age 20 and then a gradual decrease throughout the rest of the life span. All three of the papers include data points that could be schematically represented by the illustration in Figure 2.

Shepherd and Cavanaugh (1978) reviewed the effects of training on the aging process and compared their sample of master athletes with other values in the literature. This study again points out the potential for aged individuals to increase their maximum levels of oxygen uptake capabilities. DeVries (1971) devised a formula for indicating a minimal level of exercise necessary for cardiovascular adaptation in older men. In a later study Adams and DeVries (1973) demonstrated that exercise training effects could be achieved in aged women comparable to those effects in older men and younger women. Studies by Terjung, et al., (1973) and Pollock, et al., (1976) demonstrated

again that exercise training can be achieved in older men in terms of myocardial contractility (Terjung, et al.) and in maximum oxygen uptake (both groups of investigators) although the training intensities for the two studies were considerably different. It can be concluded from the above studies that exercise training can induce adaptations in aged populations; however, there remains a gradual age related decline.

The effects of the aging myocardium and its response to exercise has been reviewed by Gerstenblith, et al., (1976). These authors especially review the decreased contractility associated with aging and exercise and attribute this to the decline of myofibrillar ATPase activity. The authors also illustrate that maximum heart rate, stroke volume, and related oxygen differences are all lower.

Tomanek (1970) observed that aging in rats was associated with a decrease in the concentration of capillaries while an exercise program improved the capillary/fiber ratio. In his trained rats he found a bradycardia after 8 to 12 weeks of training. The author comments that the old animals were generally slower to adapt to the stress of the training than younger groups, however, the old animals did eventually achieve a comparable (although slightly lower) level of training.

Abu-Erreish, et al., (1977) recently demonstrated that isolated heart preparations from older animals perform less cardiac work and utilize less oxygen and palmitate in relation to heart mass. The authors report that the tissue levels of total carnitine and long chain acylcarnitine derivatives were greatly reduced in the older heart. These values are consistent with the data of Hansford (1978).

Meerson, et al., (1978) recently published an article on RNA and protein synthesis in the myocardium during hyperfunction and aging. The authors observed that physiological aging and long term cardiac hyperfunction (produced by a co-arctation of the abdominal aorta) produced similar results: RNA concentrations decreased, the rates of RNA and protein synthesis decreased, and the rate of RNA degradation decreased. The authors concluded that long term cardiac hyperfunction and hypertrophy speeds up the natural aging of the myocardium. These aging results are consistent with the myocardial results in our own laboratory (Starnes, et al., 1978) but their results were achieved in six months via abdominal aorta constriction and it is unlikely that this type of surgical procedure is comparable to that observed through exercise training.

Studies by Kuta, et al., (1970) and Parizkova, et al., (1971) demonstrated that aging skeletal muscle can adapt to physical training. In the study by Kuta, et al. it was demonstrated that men in the 8th decade of life had muscle strength at least equal to inactive men 10 years younger. Parizkova, et al. indicated that the number of capillaries per square millimeter in skeletal muscle was the same in young and old subjects while the number of muscle fibers per square millimeter was significantly higher in the old. These data indicate that considerable muscle atrophy occurred in older subjects which would give higher capillary/fiber ratios in the younger subjects thus improving oxidative capacities. This study did not report any difference between trained and sedentary older men. The subjects in this study were over 70 years of age and the trained subjects had been participating in sports activities for at least 45 years. The data are not too surprising considering that this was a cross sectional study and the sedentary men might easily have been genetically selected.

In a study reported by Bloor, et al., (1970) it was reported that exercise (swimming) in aged rats elicited a catabolic response as there was an actual loss of body weight and organ weight and adrenal hypertrophy was present in this group. The heart weight in the aged-trained animals was 87% of the control value. The loss in weight was associated with a decreased number of myocardial fibers and decreased sarcoplasmic mass. Similar findings were reported by Tomanek (1972) in 22 month old animals that had been run on a motor-driven treadmill for a three month period. Heart weights in these animals were less than their aged matched controls as was hydroxyproline concentration. Both of the above studies did not correct for body weight which was significantly lower in their trained animals. This might account for the lower heart weights. In our studies (McCafferty and Edington, 1974) we found heart weights were increased in trained compared to pair fed controls (body weights equal).

Suominen, et al., (1975,1977) indicated that in subjects aged 33 to 70 the trained persons had higher values of muscle malate dehydrognase, succinate dehydrognase, and prolyl hydroxylase activities. All of their subjects showed increased oxygen uptake values (approximately 10 to 15 percent) and increased enzymes within the skeletal muscles associated with aerobic metabolism. These studies also indicated that connective tissue is stimulated by training in aged subjects similar to that observed in younger subjects.

This review has demonstrated that training-induced adaptations occur in aged humans and animals although the time course for the adaptation is much slower. Regular habitual exercise

results in a decreased rate of the annual decrement associated with aging.

The primary emphasis in future research should be in the areas of (1) longitudinal studies of various intensities of training to assess the annual decrement, (2) methods of initiation of training studies in the aged (since the rate-of-adaptation is considerably less), (3) studies designed to determine the maximum trainability of aged subjects, and (4) animal studies to assess the subcellular mechanisms associated with aging and training.

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Bigger, Faster, Stronger — Power Weight Training

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In this presentation the members of the panel will attempt to do the following:

1. Provide a background of terms used in strength training.
2. Provide a brief review of the research concerning the use of machines to develop strength.
3. Present a power weight training program that can be used to develop strength.

For our presentation, strength will be defined as the ability to exert force. The key to developing strength thus becomes the change that a training program can bring about on the development of force. Force is the unit quantity which produces a unit acceleration. Force is the basis of all motion (Newton's first and second laws), and most sports are games of great motion by both players and equipment.

Another aspect of movement is the concept of power. Power is defined in terms of the rate at which energy can be released or is the rate of doing work. The formula for power is: $\text{power} = \frac{\text{force} \times \text{distance}}{\text{time}}$. Distance divided by time equals speed, and thus the two factors in power are force or strength and speed. In order to affect power, then, a training program must either affect strength or speed, or if possible, both of the factors at the same time. Of these two factors, it is much more difficult to bring about changes in speed than in strength.

If strength is the ability to exert force, and force is a tendency to cause a mass to change motion, then the ability to develop or maintain velocity, that is, to accelerate or to maintain velocity against resistance, depends upon the strength available and the mass or weight of the object. Since the athlete is interested in developing velocity quickly (acceleration), then the rate at which strength can be utilized is of great importance in the development of power. If more work can be accomplished in a given time frame, then a person is more powerful. How many athletic contests are won or lost due to the amount of work done in the time allotted?

Other terms that are used in strength training that will require definition in this presentation are:

1. isometric contraction - muscle contraction with little or no movement
2. isotonic contraction - muscle contraction with movement
3. repetition - one complete muscle contraction
4. repetition maximum (RM) - the greatest amount of

force that can be exerted for a given number or repetitions, i.e., 1RM, 6RM.

5. set - a given number of repetitions
6. recovery period - rest period between sets
7. isokinetic exercise - a form of isotonic strength training accomplished utilizing machines which theoretically move at only a constant pre-set rate of speed through a range of movement, once enough force has been generated to initiate the movement. Resistance is encountered in only the concentric phase of the movement.
8. variable resistance exercise - a form of isotonic strength training accomplished utilizing machines which theoretically cause the resistance load to vary in synchrony with the body's ability to apply force. Speed is not pre-set and each repetition includes a concentric and eccentric phase.

Improvements in muscular endurance, motor ability, and athletic abilities are associated with the individual's muscular strength. Thus, strength development may be considered not only a basic physical fitness need, but is also fundamental to the total physical education program. People are constantly looking for training methods which will be a more efficient mode of developing strength.

MACHINES AND THINGS

The machines of the early 20th Century were designed to make exercising more convenient or to offer resistance in positions where resistance could not be effectively achieved if the exerciser used free weights. There have been some changes since then. These changes can generally be categorized as either Isokinetic or Variable Resistance in nature. Both types of machines were developed to provide resistance in consonance with one's ability to apply force at different positions in a range of motion.

The most well known of the isokinetic machines is manufactured by the Mini-Gym Corporation of Independence, Missouri. The most successful piece of equipment they have developed is what they call their "Leaper." The basic cost of this machine is $995.00. Attachments for bench press and dead lift can be purchased for about $400.00. Their "power rack" is also well received. It sells for $825.00. The grappler, 50 x HRFS, developed to be used by wrestlers, sells for $650.00. Other popular models include their swim bench for about $500.00, the knee machine for $650.00, the bench press costing about the same--$650.00, and a lat and shoulder unit for $550.00. Each unit can be equipped with an electronic accumulative readout mechanism at a cost of $300.00 per station.

Cybex Corporation of New York, manufactures some isokinetic exercising equipment, however, their primary market has been in the areas of rehabilitation. When strong athletes started using their bench press and leg press stations for conditioning it was determined that the machines needed redesign. Those two stations have been out of production now for approximately three years--the latest revised date on availability is 1980. They are

currently marketing an Orthotron A+ ($1900) and what they call a Cybex II at a total cost of $13,585.00.

The most interesting characteristic of this device is that it produces a graphic printout of the torque developed at any point in a range of motion. With this machine strength tests can be made on most movements of the ankle, knee, hip, shoulder, elbow, and wrist.

Research comparing isokinetically trained individuals to those trained on other systems generally produces data favoring the use of isokinetic devices. Perhaps the best known of these comparative experiments is that reported by Dr. Tom Pipes and Dr. Jack Wilmore (3). One of the most interesting strength training concepts is that of hi-speed isokinetic work. Studies on this training system support it as being somewhat superior to others. Other meaningful studies on isokinetic resistance have been reported by Rosentswieg and Hinson (4), Shephard (5), and Staheli (7).

Other isokinetic devices include Hydra-gym (the 13 station unit sells for $3,895.00) and the Exergenie ($35.00).

The Nautilus Equipment Company was the first commercial organization to strongly emphasize the theoretical benefit of variable resistance exercise.

The unique feature of these machines are the variable shaped cams which provide the variable resistance. Their most expensive item is the compound leg machine at $3,465.00, perhaps the most popular machine, the pullover/torso arm costs $3,245.00. Other machines include the leg curl ($985.00), Double chest ($2,985.00) and the Hip and Back ($1,945.00). Research comparing Nautilus and other training modalities does not support Nautilus' claim of a superior training system, Silvester (6), Stiggins (8), Alarotu (1).

Universal and Paramount also manufacture variable resistance units--each costs approximately $5,600.00 for a 10 station machine. Variable resistance is achieved through a design which causes the position of the resistance on a lever arm to change as an exercise movement proceeds.

Research comparing Universal and Paramount variable resistance equipment generally shows that both systems facilitate strength change, but neither is superior to the other. One study conducted by Ariel (2) produced data showing Universal's DVR bench press station to be superior to free weights.

For deconditioned people, strength can be increased by pushing or pulling on anything, if enough force is generated. However, this is probably not true for well conditioned athletes. What system of training is most effective for them? I have had the opportunity of associating with many very strong, capable athletes. Without exception, they use a free weight program as the basis of their strength training. I have yet to meet a person I consider very strong who uses machines exclusively to maintain his strength.

How To Write A Proper Prescription For Power Weight Training

Power weight training with olympic barbell sets is the best way both men and women athletes can develop physically. It is also an exciting and most progressive method of teaching physical education weight training classes at the high school or collegiate level.

Power weight training is the utilization of very heavy weights in developing the most important muscle groups an athlete uses in competition. The foundation of strength and power is centered in the hips and legs. Power weight training develops the strength necessary to generate a greater summation of force in activities such as blocking, tackling, throwing, jumping, and running.

Many exercises found in ordinary weight training are eliminated or certainly understressed as to their importance. The number of exercises is reduced to four so that each one is most important. When ten or twelve exercises are employed with ten repetitions, it is virtually impossible to attain the same physiological and psychological heights desired.

A. Three day a week program:

MONDAY	WEDNESDAY	FRIDAY
1. Bench Press	1. Dips	1. Bench Press
2. Squats	2. Cleans	2. Squats
3. Stiff Leg Dead Lifts	3. Dead Lifts	3. Dips

B. Four day a week program:

MONDAY	TUESDAY	THURSDAY	FRIDAY
1. Bench Press	1. Dead Lift	1. Bench Press	1. Stiff Leg Dead Lifts
2. Squats	2. Cleans	2. Squats	2. Cleans
3. Dips		3. Dips	

Basically 5 heavy sets of 1-5 reps on the squat and bench press.
Basically 3 heavy sets of 1-5 reps on the cleans and dead lifts.

STANDARDS* OF EXCELLENCE

	Squat	Bench	Dead Lift	Clean
H.S. Girls	1 to 1½ x b.w.	⅝ to 1 x b.w.	2 x b.w.	¾ to 1 x b.w.
College Girls	1½ to 2 x b.w.	1 to 1¼ x b.w.	2 to 2½ x b.w.	1 to 1¼ x b.w.
H.S. Boys PE	1¾ x b.w.	1¾ x b.w.	2¾ x b.w.	body weight
College Mens PE	1½ to 2 x b.w.	1¾ to 1¾ x b.w.	2¼ to 2½ x b.w.	1 to 1¼ x b.w.
H.S. Football	300-400 lbs.	200-300 lbs.	400-500 lbs.	175-225 lbs.
College Football	400-500 lbs.	300-400 lbs.	500-600 lbs.	225-300 lbs.

*Make some allowances for tall people.

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EQUIPMENT NEEDED FOR ONE CLASS

6 300-pound olympic barbell sets
2 bench presses
2 squat standards
6 weight lifting belts
1 pound chalk
6 45-pound plates

Cost: 1979 prices about $2,500.00

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Selected Student Characteristics and Learning From A Recreation Resource Management Gaming-Simulation

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PROBLEM

Recent gaming-simulation research has indicated that the efficacy of games as teaching tools may be partially dependent on characteristics of the students themselves. DeNike(1976), for example, reported that the amount of learning derived from the BOW AND ARROW HUNTING GAME and the CROSSING PLACE HUNTING GAME was related to specific elements of students' educational cognitive styles. This finding, and others of a similar nature, support the contention of Fletcher(1971) that researchers ought to concentrate on the identification of such relevant characteristics to find out what kinds of students benefit most from gaming-simulation.

The purpose of this research was to compare five other student characteristics with the learning outcomes from QUAGMIRE, a recreation resource management gaming-simulation, for possible associations. Specifically, the characteristics of sex, class standing, gradepoint average, gaming-simulation experience, and educational orientations were compared with students' cognitive and affective responses to QUAGMIRE for meaningful relationships.

RESEARCH DESIGN

The findings reported here are interaction effects resulting from an experiment which investigated the impact of self-role incongruence on QUAGMIRE's overall teaching effectiveness(Dustin, 1977). Although the experiment's main effects were not found to be statistically significant, the classification of the research subjects according to the aforementioned characteristics made it possible to look for other associations of importance. It should be understood, therefore, that this part of the research did not involve the testing of a hypothesis. Rather, it was an exploratory effort that was designed to yield information which would be valuable for generating new research hypotheses.

SAMPLE

The scale of the study was intentionally small. The sample consisted of 44 undergraduate and graduate students majoring in recreation and park administration at the University of Minnesota who were enrolled in an upper division course entitled "Conservation of Natural Resources." The small sample size made it possible to stay close to the data, a desirable feature of educational research.

INSTRUMENTS

Four instruments were employed in the research effort: the Student Orientations Survey(SOS), QUAGMIRE, an achievement test, and a game evaluation form.

While a student's sex, class standing, gradepoint average, and gaming-simulation experience were assessed without difficulty, educational orientations were more complex to measure and therefore warrant some discussion. It seemed to the investigator that QUAGMIRE's effectiveness for a particular student might depend on that student's general attitudes about teaching approaches, classroom procedures, student involvement in the learning process, etc.. Consequently, a research tool was sought that would collect such information. The Student Orientations Survey(SOS), developed by Barry Morstain at the University of Delaware, was thought to be an appropriate instrument. The SOS yields a profile of ". . .students' general orientations toward various philosophies, purposes, and processes related to a college education."(Morstain, 1976) The SOS consists of ten scales, two for each of the five dimensions of a college experience tapped by the inventory(Purpose, achievement—inquiry; Process, assignment learning—independent study; Power, assessment—interaction; Peer Relations, affiliation —informal association; Public Position, affirmation—involvement). It is expected that students differ in their views and attitudes along these dimensions.(Morstain, 1976) The SOS scale scores, along with the other student characteristics, were compared with the cognitive and affective responses to QUAGMIRE for meaningful relationships. Such comparisons, and a full description of the relevant SOS scales, are included in the analysis of the results.

QUAGMIRE, the gaming-simulation employed in the research, was designed to assist in the analysis of the "preservation versus use" issue as it has unfolded historically in relation to the management of the national parks of the United States. It is largely a role-playing exercise in which pressure groups representing conflicting points of view attempt to persuade a managing authority to respond to certain national park management proposals in a manner that will further their own interests. Action revolves around issues of park use and development with simulated public hearings constituting the forum for game dialogue(Dustin, 1977).

Cognitive and affective learning from QUAGMIRE were measured by an achievement test and game evaluation form, respectively. The achievement test focused on the concepts and relationships believed to be taught by the game. The game evaluation form was a composite of two existing instruments(Greenblat and Duke, 1975; Monroe, 1968) and it provided information concerning the students' feelings about QUAGMIRE as an educational tool.

PROCEDURES

Following the collection of background data, the research subjects were randomly divided into two groups. Then, depending on the treatment group to which they were assigned, they were given game roles that were either congruent or incongruent with their own attitudes about national park use and management. The students in each treatment group then played four rounds of QUAGMIRE with

correlate readings and a debriefing. Finally, upon conclusion of play, the achievement test and game evaluation form were administered. Having collected this data, all of the information sought in the research was in hand. The next step was its analysis.

ANALYSIS OF RESULTS

As indicated previously, the experimental treatment effects were not found to be statistically significant. The concern then became the extent to which any of the selected student characteristics might have been associated differentially with QUAGMIRE's learning outcomes. The statistic used for this purpose was a Pearson product-moment correlation coefficient. Only those correlation coefficients obtained that indicated substantial relationships (r=+/-.40) are discussed. Exceptions to this are those instances where a cluster of lesser associations describe a meaningful trend.

With respect to the degrees of association between the student characteristics of sex, class standing, gradepoint average, and gaming-simulation experience and the cognitive and affective learning outcomes, two marked associations were revealed. An interest in the gaming sessions was related inversely to female sex(r=-.41), as was enjoyment of the gaming sessions(r=-.30). The reason for this is not clear. Other researchers have pointed out that a gaming-simulation's subject matter simply may be oriented more toward the activities of one sex than the other(Fletcher, 1971). Whether this is the case with QUAGMIRE remains a question to be explored more fully in future investigations. A second pattern of interest is reflected by a cluster of correlations indicating a greater interest in the gaming sessions(r=.35), more enjoyment of the gaming sessions(r=.26), and a stronger belief in having learned something from the gaming sessions(r=.30) on the part of graduate students. Although the correlation coefficients, individually, indicate only a slight relationship, their combined effect speaks positively for the future of QUAGMIRE as a tool for graduate instruction.

With respect to the degrees of association between the students' educational orientations and the cognitive and affective learning outcomes, five marked associations were revealed. First, an interest in the gaming sessions was positively related to the Assignment Learning scale(r=.40). This relationship may have resulted

> Assignment Learning. The student who agrees with a high proportion of the items on this scale reports that he learns best by meeting specific, clear-cut formal requirements. His mode of learning is linear, i.e., he likes to master specified blocks or units of knowledge sequentially.(Morstain, 1976)

from QUAGMIRE's procedural format which is characterized by a series of rounds with recurring, clearly defined tasks and progressively more complex issues. Second, an interest in the gaming sessions was positively correlated with the Affiliation scale(r=.40). Such

> Affiliation. The student who prefers the manner of relating to peers expressed in items on this scale enjoys belonging to organized groups. He appears to value the assurance of friendships such affilia-

> tion provides. Furthermore, he stresses the importance of maintaining strong institutional loyalty and support.(Morstain, 1976)

an association could be explained by QUAGMIRE's emphasis on group interaction and cooperation to reach desired goals. The game's accounting system demands successful lobbying on the part of pressure groups to win. The organization and teamwork required to accomplish this may have, in turn, elicited feelings valued by those individuals scoring higher on the Affiliation scale. Third, an interest in the gaming sessions was related positively to the Inquiry scale(r=.47). This was the highest correlation coefficient

> Inquiry. "Learning is its own reward," in essence, is the expressed motivation of the student who responds positively to most of the items on this scale. He concurs with statements which stress the value of insight, the perceptions of relationships, and knowing how to learn. He expresses curiosity about many things and appears to enjoy the satisfaction of inquiry whether or not it brings with it any other reward.(Morstain, 1976)

obtained and it suggested QUAGMIRE's attraction to students who valued an exploratory approach to learning. To a considerable extent QUAGMIRE has been designed to be an exercise for exploring various approaches to national park management. Participants are encouraged to test out different management strategies and to employ creative solutions to the problems posed. Such a learning environment would understandably be appealing to inquiry oriented students. Fourth, an interest in the gaming sessions was negatively associated with responses to the Interaction scale(r=-.42). Al-

> Interaction. An egalitarian attitude toward faculty members characterizes the student with a high score on this scale. The individual sees students as fully competent to share educational decisionmaking with faculty. In this connection he expresses the belief that students should participate with faculty in planning courses and academic programs.(Morstain, 1976)

though the source of this relationship is not clear, it may be that students who professed an attitude of egalitarianism toward the learning process felt that participation in QUAGMIRE was a manipulative rather than a cooperative learning experience. Anecdotal reports from past runs of the game have indicated that there are students who hold this view. Their feelings seem to be that QUAGMIRE forces them through a series of predetermined steps to reach predetermined goals, all of which are under the control of the game operator. While this is not an altogether fair assessment of QUAGMIRE, it may help explain the correlation coefficient reported here. Finally, there was a negative association between increased self-awareness and self-understanding and scores on the Informal Association scale(r=-.41). Students scoring high on the Informal

> Informal Association. Spontaneity marks the pattern of peer relationships expressed by the student who responds favorably to this cluster of items. He expresses little need for affiliation with organized groups or for participation in formal, well-planned events. His association with fellow students also tends to be unstructured.(Morstain, 1976)

Association scale expressed little need for group affiliations and preferred unstructured activities. It seems reasonable to expect that such students would not have found QUAGMIRE a conducive environment for acquiring insights about their own behavior since QUAGMIRE revolves around group interaction and interrelationships in a structured setting.

IMPLICATIONS

The correlation coefficients reported here are important for three reasons. First, they tend to support Fletcher's(1971) contention that student related characteristics may have an impact on the teaching effectiveness of gaming-simulation. In this research the characteristics of sex, class standing, and educational orientations were found to be associated differentially with the affective learning outcomes from QUAGMIRE, a recreation resource management gaming-simulation. Second, the correlation coefficients indicate directions in which future research might proceed. For example, based on these findings, research can be recommended which 1) investigates in more detail the relationship between player sex and the teaching effectiveness of QUAGMIRE, 2) ascertains more fully the effectiveness of QUAGMIRE as a teaching tool for graduate instruction, and 3) examines systematically the effectiveness of QUAGMIRE for students who have markedly different educational orientations. Finally, the reported correlation coefficients support the argument of those who insist that devotees of gaming-simulation must recognize what has already been learned about many other educational approaches; namely, that gaming-simulation does not possess inherent qualities which make it highly effective for all students(DeNike, 1976). Rather, it appears to be effective for particular types of students. The challenge for researchers remains in their identification.

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Land Managers' Perceptions of Risk Recreation in the Northern Rockies

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While several researchers have studied the risk recreation phenomenon from the viewpoint of the participants, land managers' perceptions of risk recreation have been little studied (but see Dunn and Gulbis, 1976). The increasing popularity of participation in high risk activities has been well documented (Meier, 1977). If the management problems created through risk recreation are identified now, better recreation management programs may be developed before participation becomes even more widespread.

The present study attempted to determine the frequency of participation in high risk recreation activities in the Northern Rocky Mountains, and to identify how wildland and forest managers perceive the presence of such activities and the problems associated with them. The sample consisted of all U.S. Forest Service district rangers, National Park Service superintendents, and Bureau of Land Management area or district managers in Montana, Idaho and Wyoming. Of the 160 questionnaires mailed, 123 were returned and 112 useable for a response rate of 70 percent.

Using five-point scales, the land managers rated the perceived risk, management difficulty and appropriateness given management objectives for each of 23 recreation activities, and supplied the use level for each activity occurring on lands under their jurisdiction. For activities the managers had rated as risky or difficult to manage, they also indicated the reasons underlying their ratings and any proposed or implemented management steps to reduce the risk to participants. The managers also rated a list of 11 potential problems confronting recreation managers, stated their views on search and rescue or evacuation issues and provided demographic information.

When combined with recreation, the term "risk" may be defined many ways, including possible loss, uncertainty or the probabilities of various outcomes. In this study risk was defined as physical danger to participants. The oft-debated question of how to distinguish between high and low risk activities and what criteria to use in rating risk was passed on to our responents. By rating their perceptions of the risk inherent in the activities, they developed a hierarchy of risk recreation activities, which then became the standard for further analyses.

Results The 23 activities, their mean use levels and ratings of risk, appropriateness and management difficulty are shown in Table I, with the activities listed in descending order of risk. Hang gliding, skydiving, rock climbing, kayaking and ski mountaineering received the highest ratings of risk. The hierarchy of activities may be clarified by seeing what factors were related to the ratings of risk, and then by studying the reasons underlying the managers' ratings. Perceived risk was unrelated, however, to the manager's age, education, years of management experience and size of area.

It did seem possible that perceptions of risk could be related to the use level of an activity. This was the case among high risk activities such as rock climbing, ski mountaineering, dirt biking and snowmobiling, where the risk was rated as higher by managers of areas that experienced higher use levels. On the other hand, low risk activities received uniform ratings of risk across all use levels. Experience in managing high risk activities may make managers more aware of the actual risks involved, leading to a clearer (and higher) judgement of risk, although no such causal relationship was identified empirically.

The managers' reasons for rating risk as high also revealed differences in the perception of high and low risk activities. Terrain Hazards (including rugged terrain, rough or fast water, turbulent currents, hidden or buried obstacles and avalanches) were cited most frequently as factors contributing to risk, followed by User Inexperience, Human Factors, Weather, Equipment and Human Error. Among high perceived risk activities, Human Error (getting lost, carelessness, recklessness, speeding, overconfidence and disregard for safety) was seldom mentioned as a factor leading to risk. For low risk activities, however, Human Error constituted up to 50 percent of the reasons why managers rated an activity as risky.

The managers may have assumed that participants in high risk activities were qualified to participate, and that risks stemmed from more objective hazards such as terrain or weather. If so, the managers discounted the human element in risk recreation activities, which they viewed as risky regardless of the participant. While Inexperience was cited more frequently than Human Error as a factor related to risk, the proportion did not differ between high and low risk activities.

By viewing the management steps that had been proposed or enacted to reduce the perceived risk to participants, insight was gained into the perceptions of risk. In most cases, the managers took no steps to reduce risks to the participants, even in high perceived risk activities. There were no differences in either the absolute numbers or types of management steps enacted between high and low risk activities. Registration and User Certification were proposed more frequently, however, for high risk than low risk activities. Signing, Improving Services or Facilities, Education/Information, Personal Contact with Users and Area Closure/Designation headed the list of steps proposed to reduce risk. Area Closure/Designation was the step most often taken to reduce risk, though, and User Certification was also highly represented as based on its proportion in the list of proposed steps. When managers actually implement actions to reduce risk, they tend to be more restrictive.

Now that the perceptions of and reactions to risk recreation have been illuminated, let us see if high risk activities were rated as more difficult to manage or as less appropriate than low risk activities.

As shown in Table I, the management difficulties associated with high risk sports numbered no more than those created by low risk activities. The activities most difficult to manage included those utilizing motorized modes of travel and hunting, which had the highest mean use level of the 23 activities. The specific difficulties faced most often

included enforcement, resource damage and lack of control. Factors other than perceived risk probably play a greater role in perception of management difficulty of an activity, although hang gliding and skydiving were rated as relatively difficult to manage.

Table I also reveals that the list of activities rated as inappropriate was dominated by high perceived risk and motorized forms of recreation. The distribution was highly skewed, for many activities were viewed as inappropriate. Why were high risk activities also rated as inappropriate? It is possible that the managers, and many other people as well, have not given much consideration to risk recreation, and especially not to hang gliding and skydiving. Their ratings may reflect a basic bias against such "bizarre" forms of recreation. If so, risk recreation participants may have to legitimize their sports in the eyes of the land managers; perhaps this will come with increased contact. There may be more specific reasons why high risk activities were viewed as inappropriate, but it should be remembered that inappropriateness was unrelated to either management difficulty or reasons for high ratings of risk.

Observation of Table I immediately reveals the extremely low use levels of many high risk activities. This was reflected by the managers' ratings of potential problems in recreation management; the Increase in Risk Recreation Activities was rated next to last of 11 problems. Mean use levels for some activities should be interpreted cautiously. For example, an area which contains a ski facility within its boundaries will have a very high use level of downhill skiing, while an area which does not will have a use level of zero.

It has already been shown that the use level of a high perceived risk activity may influence the rating of risk. Perhaps the use level interacts with management difficulty and/or appropriateness as well. It may thereful be useful to see how these four variables interact across the 23 activities.

The resulting typology of activities (Table II) not only further sheds light on the value of the risk variable, but contains implications for recreation management. None of the activities rated as high risk were viewed as both appropriate and easy to manage. The element of perceived risk may therefore be related to a manager's global perception of recreation activities. It was also found that water skiing, rock climbing, skydiving, hang gliding and caving were all rated as high risk, inappropriate and difficult to manage; all, however, exhibited low use levels. If use increases in these activities, as it undoubtedly will, monumental problems may result. Managers would be well advised to closely monitor use levels in these five activities. Recreation participants should also keep this mind, for if use in high risk activities increases, perhaps the land managers would actually implement their proposed restrictions to reduce risk to the participants.

Finally, the managers offerred their views on emergency medical treatment, search and rescue and evacuation, all of which are usually associated with high risk activities. The managers were somewhat divided on who should be responsible for such operations (my agency, another agency,

the state or county, or the recreationist), although 44 percent believed this burden should fall on the recreationist. A full 77 percent, however, felt that the recreationist should pay for the costs incurred on such missions. The managers' comments on the issue contained a wide range of views. Some adopted a laissez-faire policy towards participants in high risk activities:

> The individual must bear his own responsibility and proceed at his own risk. Society picks up too much of the tab already!
>
> Recreationists tend to depend upon the agency whenever conditions are unfavorable, when the recreationists know the agency will pay for evacuation. Recreationists with this dependence enter the backcountry with less mental, physical and material preparation.
>
> They come at their own risk...

Some managers say it depends on the situation:

> To a growing number, the risk is part of the experience. Only when the agency and its manmade facilities are at fault should the agency pay.
>
> If the search and rescue mission is because of negligence on the part of the recreationist, he or she should pay. If it is an act of God situation, it is appropriate for the agency to bear the cost.

Yet another group of managers felt responsible for recreation participants, even if they were taking chances:

> The taxpayers pay for our equipment and wages. We should be available to help them in an emergency.
>
> Once there is an emergency, all public agencies have a responsibility to assist in whatever capacity possible. However, it is not necessarily proper for them to expend funds in maintaining rescue teams just for these contingencies.

Conclusions Land managers' judgements of the risk inherent in recreation activities appears to be one of several variables predicting their perceptions of and management responses to recreation management problems. The findings reveal, however, that one may not infer such management reactions based on perceived risk alone.

Future research is needed to determine why some managers feel a need to protect recreationists by taking steps to reduce recreational risks, what steps are effective in reducing risk (and how this effectiveness is measured), and the recreationists' feelings towards these steps. Studies of land areas where use levels in risk recreation activities are already high may better prepare land managers to face use increases on lands under their jurisdiction.

problems created by participation in risk recreation. Eiseman (1976) stated, "Physicians are going to see an increasing number of injuries from hang gliding and we might as well learn about this new sport so that we can cooperate in minimizing the risk in what is inevitably a high-risk leisure activity." His goal seems remarkably similar to that of the land managers who have taken management steps to reduce the risk in some forms of recreation, and points out the value of a multi-disciplinary approach to the study of risk recreation. Land managers, doctors and professionals in a number of other fields should be able to pool their knowledge and methodologies to better understand the growing interest in and results from participation in risk recreation activities.

TABLE I Manager Ratings of Selected Recreation Activities

Activity	Risk[1]	Appropria-teness[2]	Mgmt. Difficulty[3]	Use Level[4]
Hang gliding	65	69	24	37
Skydiving	54	75	24	4
Rock climbing	50	37	14	214
Kayaking	43	43	13	146
Ski mountaineering	43	30	17	169
Caving	33	50	20	104
Canoeing	31	35	11	489
Snowmobiling	28	10	38	6708
Dirt biking	27	46	69	2267
Water skiing	26	52	25	324
Downhill skiing	24	45	14	10818
Winter camping	20	17	11	242
Scuba diving	19	62	19	14
Rafting	17	38	16	1177
Cross-country skiing	14	9	14	1601
Swimming	13	24	13	1809
Off-road driving	13	50	75	3739
Motorboating	13	40	19	2294
Bicycling	14	44	4	435
Hunting	7	4	33	28028
Horseback riding	6	7	11	3416
Backpacking	5	10	13	8594
Fishing	0	4	13	25485

1. Percent rating risk as high or very high
2. Percent rating appropriateness as low or very low
3. Percent rating management difficulty as high or very high
4. Use level in visitor days from 9/77 to 9/78

TABLE II Four-Variable Typology of Selected Recreation Activities

Risk	Inapp.	Diff.	Use	Activities in Category
High	High	High	High	Dirt biking
High	High	High	Low	Water skiing, rock climbing, caving, hang gliding, skydiving
High	High	Low	Low	Canoeing, kayaking
High	High	Low	High	Downhill skiing
High	Low	High	High	Snowmobiling
High	Low	High	Low	Ski mountaineering
High	Low	Low	High	None
High	Low	Low	Low	None
Low	Low	Low	Low	Winter camping
Low	Low	Low	High	Backpacking, horseback riding, swimming, fishing, Cross-country skiing
Low	Low	High	High	Hunting
Low	Low	High	Low	None
Low	High	Low	Low	Bicycling
Low	High	Low	High	None
Low	High	High	Low	Scuba diving
Low	High	High	High	Off-road driving, motorboating, rafting

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Outdoor Recreation and Special Populations in the State of Utah

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Special populations, including those people who are subject to a variety of handicapping conditions such as blindness, deafness, mental retardation, physically handicapped and aged, are presently receiving increased attention because they belong to a segment of society that has had some of its basic rights denied. One basic right that is often denied those included in special populations is the right to participate in outdoor recreation. Recently, this right has been reaffirmed by congress through the following acts: Public Law 88-29, The Organic Act; Public Law 90-48, The Architectural Act; and Public Law 93-112, The Rehabilitation Act. As a result of these acts, the Heritage Conservation and Recreation Service, (HCRS), which provides matching funds for local outdoor recreation facilities, has identified its greatest task as "providing adequate (recreational) opportunities for people with special needs, particularly the handicapped and the aging." (Delaporte, 1978, p. 2.) In addition, HCRS is "requiring all states to develop an action plan to meet the recreation needs of the handicapped as an element of the Statewide Comprehensive Outdoor Recreation Plan." (Parks and Recreation, 1977, p. 54.) It is in an attempt to fulfill this requirement of Utah's Statewide Comprehensive Outdoor Recreation Plan (SCORP) that this research was undertaken.

This study of special populations and outdoor recreation was designed to locate, identify and classify, within the State of Utah, the various special population sub-groups and to identify their recreational needs, their reasons for not participating, and ways of increasing participation in outdoor recreation activities.

Within the State of Utah, figures for handicapped children and the elderly population are readily obtainable. Through school board data, it was found that 17.28% of the school aged children were considered handicapped. In addition, a second category of severity, self-contained, was identified. The self-contained population included those students whose handicap is severe enough to require separate classes from the normal population for at least one-half of their school day. The self-contained population was found to be 7.5% of the special population and 1.3%

of the school aged population. The elderly population was identified through the State Department of Social Services as being 11% of the total population of the State of Utah. It is interesting to note that 70.9% of the elderly and 72.9% of the school-aged special population live in four of Utah's twenty-nine counties referred to as the Wasatch Front.

The adult special population figures are impossible to obtain. Therefore, based on the U.S. census data, this population was estimated at 14.57% of the adult population. Because the exact data was not available, it was also assumed that the majority of this population lives along the Wasatch Front since this is where the majority of Utah's population is found.

The data collection method used was a mailed questionnaire. This method was chosen due to the large sample size and area to be covered. The questionnaire was constructed by examining existing research and in consultation with state and regional HCRS officials. In this way it was determined what data was pertinent to state and regional needs. After the questionnaire was developed, it was taken to a reading specialist who wrote it in sixth grade language for ease of understanding by the sample population. The final step in validating the instrument was accomplished by submitting copies of the questionnaire to members of the special populations to be studied, for their comments and evaluation.

When attempting to identify special population members, an unforseen problem arose. Due to the Privacy of Information Act, the researchers were denied access to files or records containing the names of handicapped individuals within the state. This necessitated going to different agencies within the State of Utah and asking them to mail the questionnaires. In further compliance with the Privacy of Information Act, no names of the sample members were available, so the agencies were supplied stuffed and stamped envelopes. The agencies then placed the names of the state's handicapped population on the envelopes and mailed them. Because the names were not accessible, no follow-up letter was possible.

The reliance upon the various agencies within the state also required different sampling techniques. The techniques used were the result of agency attitude and time. The children's population was sampled based on the self-contained population only. The reasons behind this decision were two fold: 1) It was a population that was definitely handicapped. Therefore, the likelihood that the children's parents would become upset due to the term handicapped, was reduced; 2) Since their disability was more severe, it was reasoned that if facilities were provided that they could use, then people with a less severe handicap, could also use the facilities. The sample drawn from

this population was established as follows. In any one district all qualifying individuals, up to a maximum of 30, were sent questionnaires. The adult population had a history of poor response. Therefore, since the agency was statewide, all individuals currently on the roster were surveyed. The elderly population was sampled through the use of statistical methods. In samples for both the elderly and children, the agency was instructed to select at random those receiving the questionnaries. The sample sizes for each of the three populations were as follows: Children - 726; Adult - 3,060; and Elderly - 399. The total sample size was 4,185. Response rate to the questionnaire was as follows: Children - 15.3%; Adult - 23.3%; and Elderly - 30.5%. This resulted in an overall response rate of 22.7%. Under the conditions of the survey and the characteristics of the population studied, the response rate was quite good.

Data regarding the respondents were as follows: 21% were under the age of 19; 62.6% were between the ages of 20 and 59; 16% were over 60; 58.8% were male; 68.5% lived along the Wasatch Front; 50.7% lived in a household having two adults; 51.8% of the households also consisted of one or two children; 51.4% spent seven or more hours per day outside the home; and 51.1% spent less than one hour per day in outdoor recreational activities.

When asked to identify those physical factors outside the home which were considered a very serious problem, the following were identified in order of rank: 1) Transportation; 2) Boat docks and piers; 3) Toilets; 4) Spectator areas and trails. It should be noted that the order was somewhat changed when the question was, "What do you consider a problem when outside your home?" The results in order of rank are as follows: 1) Spectator areas; 2) Games areas; 3) Camping areas; 4) Trails; and 5) Transportation.

When the sample population was asked to identify the recreational area or facility used most, the following were identified in order: 1) Camping sites; 2) Picnicing areas; 3) Swimming pools; 4) Spectator areas, and hiking trails. This closely resembled the list of activities identified as those they would like to participate in.

When asked to identify what they felt was necessary to improve outdoor recreation for the handicapped, "public awareness of the handicap's specific problems" was ranked first, followed by "more outdoor recreation programs for the handicapped."

The reasons for not participating in outdoor recreation were: "Costs too much," followed by "Too busy." It is interesting to note that only 21.% of the respondents were "not interested" in outdoor recreation.

When asked what they would like to see applied to the handicapped population, "discount or no fee for park entrance or camping," was followed by "no hunting or fishing license required." This is consistent with the reasons for not participating. It is interesting to note that the State of Utah does have a discount policy in the State Parks program and no fishing license is required if the individual is participating in a state agency outing.

A question concerning a provision for wilderness access for the handicapped received a positive response from 71.1% of the respondents. The population surveyed also indicated the following as possible methods of providing this access: paved trails; roads for handicapped individuals only; bus trips; and helicopter trips; to name a few.

On closer analysis, the three populations (children, adult, elderly,) showed some interesting characteristics. The elderly population varied from the others in hours spent outside the home with 48.8% reporting they spent less than four hours per day outside the home. This was in contrast to children and adults who spent most of the day outside the home.

In the area of very serious problems encountered outside the home, transportation ranked first in all three populations. However, children listed signs and telephones as numbers two and three respectively. The elderly rated game areas second as a very serious problem.

The final variance between groups, based on age, concerned the improvement of outdoor recreational opportunities. The elderly ranked "more outdoor recreation closer to our area" first. Conversely, 41% of the children identified more outdoor recreation programs and workshops as the number one necessity.

The research suggested the following eight recommendations for the State of Utah, relating to outdoor recreation: 1) The number one need of the special population appears to be transportation to outdoor recreation areas. This can be accomplished through public means or through programs that supply transportation; 2) Another major need appears to be the immediate modification of the following facilities - boat docks and piers; camping areas; spectator areas; signs; toilets; and game areas. These six facilities appeared to be the major problem areas; 3) The development of a public awareness campaign to educate the general population; 4) The establishment of programs and workshops to teach handicapped children how to participate in outdoor recreation. This should also include some non-traditional activities; 5) To advertise the discount programs through channels that are available to handicapped individuals only. This will eliminate the welfare concept associated with reduced rates; 6) The development of areas for outdoor recreation in and

around concentrations of the elderly, especially walking trails, ranked second in activities the elderly would like to participate in; 7) Once the facilities are developed in areas of concentration for the elderly, programs must be started to encourage participation; 8) Areas that are in a natural state need to be developed to allow access to handicapped individuals only. These areas should try as much as possible to simulate wilderness areas.

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Residential Density and Recreational Participation

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I. Introduction

Changes in the manner in which everyday social life is carried out have been at the center of concern for recreationists since the inception of the so-called recreation movement. Richard Knapp (1972) has portrayed the circumstances under which the recreation movement emerged in the United States during the latter half of the 19th century. One of its earliest concerns was the consequences of urban residential patterns for the well-being of those who found themselves present therein. Although the initial concern was for the well-being of children, the continuing thrust of the population shifts during the last 75 years has broadened our concern to include all members of the society regardless of the individual's place in the life cycle. Recreationists sensed, long before contemporary emphases arose, that concentrations of human population altered the ways in which many aspects of everyday life unfolded, including recreational opportunities. Many of our programs and delivery systems for recreational services have been and are continuing to be developed based upon these accepted observations. Yet today some of these broadly accepted truisms about the necessary relationships existing between human population density and certain forms of human behavior appear increasingly less tenable. In this paper, we examine the relationship between residential density and recreational participation among a national sample of adults.

II. Literature Review

In a recent issue of the journal Environment and Behavior, Kirmeyer (1978) reviewed the existing knowledge concerning urban density and various forms of so-called social pathology. The overall conclusion was that there is little sound research available to support the often heard shibboleth necessarily connecting density of human population and pathology. Early findings linking density with pathological behavior in animal populations are being questioned (Fischer, et al. 1975). Apparently what has been thought true for some animal populations is not readily supportable for human populations. Among the studies Kirmeyer reported were several concerned with in-dwelling density and its effects upon socializing in the home. Since the home is one important locus for many forms of recreational behavior we were particularly interested in these studies.

Mitchell (1971) reported that high in-dwelling density may decrease socializing in the home as a result of less frequent

entertaining of friends. Eoyand (1974) reported a similar finding among roommates. Thus, many roommates in the same dwelling tends to reduce socializing. In short, these studies suggest that dwelling places where there are a large number of persons for the number of rooms available have reduced desirability as a locus for socializing and thus for recreational behavior which might ordinarily occur there.

Baldassare (1975) added another dimension to our understanding of the relationship between density and socializing by examining areal as contrasted to in-dwelling density. High areal density was found to be associated with less acquaintanceship with neighbors but not related to socializing out of the neighborhood. Apparently in densely populated areas one is less often acquainted with neighbors but this does not result in greater socializing contacts out of the neighborhood in any compensatory fashion.

The implications of these selected findings (from studies of density and human behavior) for an examination of recreation behavior would appear as follows:

1. High in-dwelling density appears to reduce socializing in the home hence reducing its likelihood as a locus for recreation. Assuming recreation behavior is a constant, it would seem likely therefore that high in-dwelling density would be associated with participation occuring in locations other than the home.

2. Whereas high in-dwelling density would appear to "push" recreational participation out of the home (into the streets, so to speak), high areal density reduces knowledge of one's neighbors. Since one usually participates in recreational activities with others previously known to one, this suggests that neighbors are not those from whom recreation partners are drawn. Accordingly, since high areal density was not found to be related to socializing out of the neighborhood, it would appear that high areal density (unless combined with high in-dwelling density) would not have a significant impact upon the home as a locus for recreation behavior. This would seem to suggest that areal density may prove a somewhat limited indicator for recreational planning and programing at the community level.

Unfortunately the data at hand do not permit a direct test of the relationship between areal density and recreational participation, but we can examine the relationship between in-dwelling density and recreational behavior in an attempt to assess its consequences for home located recreation which in turn has implications for non-home recreation. The research hypothesis cast in the null format is:

There is no difference in recreational participation among adults residing in high-density and low-density dwellings.

Procedure

Participation in fifteen recreational/leisure activities among a national probability sample of 644 adults was examined.

Respondents were asked to indicate the number of times they had participated in each activity during the month immediately preceding the date of the interview. From this information we created two measures of participation. One measures how extensive the participation was among the adults sampled (i.e. how many participated). The second measures how intensive the participation was among the adults sampled (i.e. how many times did participation take place). Extensity was measured nominally. Intensity was measured ordinally: low (1-2 times); medium (3-7 times) or high (8 or more times). Earlier research has suggested that these two aspects of participation are related differently to a variety of independent variables (Cheek, 1978). Thus there are two dependent variables measuring recreational participation.

The independent variable is in-dwelling density. This was measured in a widely used and standardized manner (Rapoport, 1975). For each household the respondent indicated the number of persons residing therein and the total number of rooms not including bathrooms. The index of in-dwelling density was calculated by dividing the number of persons by the number of rooms to obtain a ratio of the number of persons per room. The array of these calculated indices were divided at the mean. Those values less than the mean were designated low-in-dwelling densities while those equal to and above the mean were considered high in-dwelling densities.

Chi-square tests of independence were calculated for each of the fifteen activities for both measures of participation by in-dwelling density. The significance level of 0.1 was chosen to define the zone of rejection.

Results

The results found with respect to in-dwelling density and extensity of participation are shown in the following summary table.

Recreational Activity Listed by Related In-Dwelling Density Condition.

High Density*	Low Density*	No Relationship
1. going to movies	1. going to theater or concerts	1. dining out
2. window shopping	2. gardening	2. arts & crafts activities
3. picnicking	3. participation in club activities	3. hunting or fishing
4. attending indoor sporting events		4. reading for pleasure
5. driving for pleasure		5. riding horseback
6. watching television		
7. using off-road recreational vehicles		

* x^2 values significant beyond 0.1

Overall, a significant relationship existed between in-dwelling density and participation for ten of the fifteen activities examined. In other words, a significant relationship existed

for about 66 percent of the activities. Interestingly the relationship was not the same for all activities. For seven activities, the high in-dwelling density cell accounted for the relationship. For example, adults residing in high in-dwelling densities were significantly more likely to participate in going to movies than adults residing in low in-dwelling densities. Among three activities, it was the low in-dwelling density cell which was responsible for the relationship being present. There was no significant relationship between in-dwelling density and the remaining five activities. Of the fifteen activities examined perhaps only three (watching television, engaging in craft activities, and reading for pleasure) are most likely to occur in the home. Only one of these activities had a statistically significant relationship to in-dwelling density. From these activities alone, it is difficult to make a convincing argument about the acceptance or rejection of the hypothesis derived from the density literature. What does seem apparent is the presence of empirical relationships between in-dwelling densities and the extensiveness of adult participation among selected recreational/leisure activities.

Considering the second aspect of participation, intensity, there was only one statistically significant relationship found with in-dwelling density. Low in-dwelling density households were found to dine out more intensively than high in-dwelling density households. Apparently among these 15 activities in-dwelling density does have consequences for whether adults do or do not participate, but has no significant influence upon the intensiveness of their participation.

Conclusions and Implications

These results are descriptive. Their importance lies in the identification of empirical relationships between participation in recreational/leisure activities among adults as related to in-dwelling densities. Based upon these observations we may begin to have confidence that our professional concerns about density and recreational behavior are grounded upon more that mere tradition or astute professional judgement. In an age of empiricism where we seem destined to justify all of our programmatic efforts, these findings are encouraging. But we believe they are more than that alone.

These results suggest that the relationship between in-dwelling density and recreational behavior is more complex than perhaps we have thought. Different activities related to different empirical conditions of in-dwelling density including some where no relationship appears present. This suggests that in-dwelling density may be a much more versatile index for recreational planning and programing than it has been traditionally considered. More than a condition necessary for certain forms of recreational behavior to occur or not occur, it appears to be a variable with multiple effects upon a variety of activities and aspects of participation among adults. We believe the difference in the results between extensity and intensity of participation is especially suggestive for recreational delivery system planning.

Although we are encouraged by these preliminary results, we would be unwise not to recognize their limitations. Perhaps the

most severe limitation is the narrowness of the range of recreational activities examined. Clearly replications of these findings using other recreational activities is desirable. The well-known limitations of any single study goes without additional comment. For some, another level of significance may generate greater confidence in the stability of the empirical results. We believe however that the stage of development at which our field presently stands requires the greatest possible attention to the identification of empirical relationships wherever present. For example, given the results in this study we may begin to ask if there are certain characteristics commonly shared among the activities examined which differentially relate to the condition of low and high in-dwelling density. Future research will hopefully, not only replicate these findings, but expand our understandings of why we have obtained these particular results. For only through cumulative results will our knowledge base expand.

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A Descriptive Answer to the Question of Kinesthetic Imagery

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This paper is an abridged and simpler version of a lengthier essay which will ultimately be published elsewhere.[1] I mention the longer essay here merely to emphasize the complexity of the subject and its reputation for being elusive. Though no longer considered a prize catch by any means, kinesthetic imagery was pursued for some years in the first half of this century by some notable people: one of the ranking psychologists of the turn of the century, E. B. Titchener, studied the subject and concluded that, "kinesthetic images are extremely difficult to distinguish from kinesthetic sensations."[2] By 1940 when the philosopher Sartre had published The Psychology of Imagination, the situation or verdict had not appreciably changed. Tracking a kinesthetic image proved to be as negatively productive by the 1940's as it was 30 or 40 years earlier: confusion seemed to be the accepted descriptive term for kinesthetic experiences which ostensibly involved kinesthetic imagery, the latter being consistently confounded with perception.

In view of such a reputation, one might ask quite legitimately whether a kinesthetic image is analogous to an abominable snowman. Perhaps all the fuss has been over something which does not exist and never has existed--a wholly hypothetical entity. In answer, one might counter that because of a strong bias toward language, we are simply hesitant to confer reality on something which though perceived, does not have a name or the name of which is merely a generality. What do we perceive kinesthetically, for example? The best we can come up with is a "pull," a "heaviness," and the like. The "what" of our kinesthetic perceptions lacks precision, color, and variety so far as language is concerned. As we grow into a verbally-oriented world, perhaps we proportionately outgrow an awareness of things which, in our everyday lives, we cannot easily talk about. Now if kinesthetic perceptions are so easily disposable, kinesthetic images must be equally so.

There are other beguilements besides language which might be pointed to as clouding the reality of kinesthetic imagery. James Joyce wrote of the "ineluctable modality of the visible." Though it resounds far less mellifluously, one might with substantial insight speak in contrast of the "eluctable modality of the kinesthetic," not only in terms of perception of course, but in terms of imagination as well. While visual images suffuse our everyday lives--when we hear the doorbell ring and wonder for a moment who it might be, for instance, or when we are getting directions or writing to a friend, or when we are asked to remember a certain number or think in geometrical terms--kinesthetic images, in contrast, appear not only hard to come by but difficult to describe. Visual experiences come in shapes and lines, that is, in the form of definitive objects: they have a certain describable form--enormous, rounded, jagged, contracted, ball-shaped, triangular, vertical, columnar, pointed, or whatever, and in whatever combinations.

or) they rise up or stand out as particular objects for us.

Not so with kinesthetic imagery. Although kinesthetic images, like kinesthetic perceptions, may be either a matter of bodily tensions, strains, heavinesses, and so on, or a matter of pulsating energies, that is, a matter of movement, experiential analysis show that they are images without definitive spatial form: they are not a certain shape or a certain size and neither do they have a certain directionality by virtue of their linear design or pattern. They do not have any visual attributes anymore than kinesthetic perceptions have visual attributes. Just because kinesthetic images are locatable--they are not altogether aspatial forms--does not mean that they have a definitive spatial form. On the contrary, they do not begin or end anywhere: they are amorphous entities. As such, we can understand not only how it is that they do not have distinguishing names, but how they do not even count as objects in the first place. It is not that a kinesthetic image is not objective, but that it is not an object in the sense of being a spatially-bound entity like other properly behaving objects.

If such insights are possible through experiential analysis, then surely the question of whether kinesthetic imagery exists or not is to be answered only by such an analysis. The immediate impetus to take up the question came for me in the form of an unexpected teaching assignment last fall: a course dealing with imagery and dance. In the process of completing the readings preparatory to teaching the course, it became clear that the people who were trafficking in kinesthetic imagery were not sufficiently attuned to being in the body to grasp the subtleties and varieties of kinesthetic experience and that dancers might be in the best position to come to terms with the issue because of their focus.

My class of 13 graduate and undergraduate students regularly and inevitably came to grapple with some sticky but basic questions and issues, first and foremost among them, "What is a kinesthetic image: describe it." This question threaded its way throughout our classwork--an eight-week experiment, readings, movement sequences, lectures, practical imagery techniques, discussions, and the like. Readings spanned the books listed in the bibliography. Our quest was on both scientific and philosophical grounds and while we pointed up intractable shortcomings in scientific accounts, we were not uncritical of philosophic accounts even though those accounts convinced us that the only way in which one could come to understand kinesthetic imagery and resolve its complexity was to go back to the experience itself and ultimately, render it phenomenologically. Perhaps the clearest and simplest way of demonstrating the grounds of our conviction is by the following two not altogether hypothetical examples.

If a random group of dancers were asked, "Do you have kinesthetic images?" or if a random group of dance teachers were asked, "Do you use kinesthetic imagery in teaching?," the answer in each case would undoubtedly be an enthusiastic "yes!" If the person were then asked to describe an experience in which a kinesthetic image was had or was used in teaching, it would turn out that the description was of a visual imaginative form. In other words, what was taken or assumed to be kinesthetic imagery was in fact visual imagery. Telltale clues would abound in the form of words which are descriptive of shapes and lines--visual entities. The

person would be surprised to find that there were no kinesthetic apparencies, that is, that the image actually lacked any attributes which might qualify it as kinesthetic.

The second example points up how kinesthetic imagery might be confused not with visual imagery but with kinesthetic perception. If one would ask a dancer or a teacher of dance to recall a kinesthetic image or to create a kinesthetic image on the spot, and if one asked either person to say, after the experience, whether there were any actual movements going on while they experienced the image, the person might answer either "yes," "no," or "I'm not sure." If the person answered "yes," there is a problem in that perceptions are getting mixed up with images. In effect, how does one tell the difference between an image and a perception? If the person answered "no," and you say, "But I saw your head moving and there was a slight movement in your fingers," the person might go back to the experience and discover that indeed, he or she was moving, or the person might find that he or she was unsure of whether actual movement was taking place or not. If the person answered "I'm not sure," we are left in the air as to the possible difference between kinesthetic imagery and kinesthetic perceptions, the same as we were if the person agreed that, yes, in fact, he or she did have perceptions in the course of imagining. In sum, there is confusion at times about whether one is kinesthetically perceiving or kinesthetically imagining. How is such a situation possible? Surely one can tell whether or not one's body is perceptually or imaginatively present--or can one? If one can, then what is the differentiating feature(s) which separates a perceptually felt presence from an imaginatively felt one?

By going back to the experience without preconceived ideas as to what is involved or what we will experience, we come to understand how a kinesthetic image appears and ultimately gain some insight into why it is easily confused with kinesthetic perceptions or visual imagery. We also gain some insight into why a kinesthetic image is at times as elusive as a neutrino and indeed at times seems descriptively akin to a neutrino. Since it has no definitive spatial form, the object of a kinesthetic image might also at times be described as a disembodied spin. Accordingly, the question, how can something which has no mass be turning?, is a question which might be asked of a movement image as well as a neutrino.

What else, then, does an experiential analysis reveal other than that a kinesthetic image is a non-definitive spatial form? It reveals that such an image may appear in one of four ways. In three of these ways, one imagines oneself as different in some way from the way one now actually is: as being in a different position from the one in which one now is; as feeling different strains, pressures, tensions, or heavinesses from those one now actually feels; or as moving rather than static. We see then that it is a question of either imagined positions, imagined tensions, or imagined movement. The fourth way in which a kinesthetic image might appear involves no disparity between how or where one is in actuality, and how or where one is imaginatively: one is not different in some way from the actual way one now is, but one realizes that way imaginatively as a kinesthetic form.

Now without going into the analytical detail which would provide the background for the statement, let me simply say that in order that any of these images appear, the actual kinesthetic body must not be present. My lived felt body must somehow be trans-

cended if I am to render it imaginatively. If my awareness is consumed in actual strains, tensions, or movements, then I cannot be imaginatively engaged: my attention is on perceptual, not imaginative apparencies. The problem, of course, is how can I be absent from myself? Put another way, how can I exist as a non-spatialized presence to myself? Not that an image is non-spatial but that the spatiality of my lived body must be somehow preempted in kinesthetic imagery.

Answers to these questions emerged in the course of the analysis. Essentially, it was discovered that to have a kinesthetic image is to lose one's bodily boundaries. One can transcend the perceptual world of the felt lived body only insofar as one loses awareness of where one begins and ends, so to speak. Only where there are no beginnings and endings in a spatial sense, where there are no definitive spatial forms, is it possible to form a kinesthetic image. Amorphous entities and a loss of boundaries are different sides of the same coin. It is in and through them that we differentiate between imagery and perception as between visual and kinesthetic imagery.

This is not to say, however, that kinesthetic images might not be intertwined with visual images or that a kinesthetic image might not have a perceptual aura to it. For example, through a diffusion of attention, I might experience concurrently a kinesthetic image and kinesthetic perceptions. "Diffused attention" is similar to what is called "full retinal vision," which in turn is opposed to "foveal vision," the former being an experience in which the eyes are not precisely focussed upon any one thing in particular: the latter being an experience in which the eyes converge upon a single object. In full retinal vision, the world is spread out such that awareness expands: otherwise marginal items exist on par with everything else in the visual field. There is, in fact, no longer peripheral vision: my vision encompasses everything it sees equally. Thus we find a possible explanatory compliment to our descriptive study: given that one thing does not assume greater experiential importance than any other, we may understand why it is people might have difficulty separating out the image from the perception as they reflect back upon an experience. On the other hand, we might note that, if one tries to focus the eyes on a visual image while having the experience, for example, the image disappears. In other words, if we try to use perceptual techniques on images to grasp them more precisely or to track them down, the image accedes by disappearing.

Insofar as the first three kinds of images involve the creation of a body which is different from the body as it now is, perceptual intertwinings may occur: we accomodate the image with some form of movement somewhere in our body. There may indeed be "tentative movements," as Washburn dubbed them. But Washburn was not sufficiently engaged in the practice of her profession to discover further that these tentative movements are varied and may be taken up by diverse parts of the body. Often they occur in parts not actually engaged in the image as when, imagining myself frowning, I feel a slight constriction or tightness in my chest. Frequently too, they may involve a change in breathing. In experiences of kinesthetic imagery where my body is in some way different from the way it is now, there is often a peculiar and spontaneous shift in breathing which brings my breath in some kind of consonance with the image. If I try to realize the image without the change

in breathing, I cannot succeed in forming the image.

There is a certain satisfaction in the fact of this possible intertwining of perception and imagination: the lived body is all of a piece. One can perhaps most easily and readily appreciate this integrity by imagining oneself in the act of swinging an ax to chop down a tree or of swinging a bat hard and horizontally at an on-coming baseball at the same time that one actively, that is, actually inhales. The image does not work: the imaginary swing is truncated or comes to naught. Although one might want to separate out the perceptual from the imaginary, experience does not always yield, and if it is a question not of imagery in general but kinesthetic imagery in particular, we may be sure that it is a question of the lived body. It is only when researchers on imagery approach the subject as a purely mental act or when they build into their analysis a strict Cartesian dualism of mind and body, that they are able to uphold their distinction between perception and imagination as separate mental acts or as separate modes of consciousness and skip over kinesthetic imagery as merely "feeling in the mind's muscle,"[3] for example. (As dancers clearly know, the mind is a muscle, it does not have one.) A kinesthetic image is, on the contrary, a complex of possibilities, each of which needs to be described and all of which need to be essentially understood. This understanding may well lead us to find in the lived body the source of all imaging. As Merleau-Ponty wrote in his last working notes before he died: "Understand the imaginary sphere through the imaginary sphere of the body."[4] A challenge and perhaps a task for the future.

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Because of space limitations, references in the text have been all but omitted. What is lacking in reference material may be supplied by the bibliography which, though considerably trimmed, offers basic sources consulted.

1. For more information, contact the author.
2. Titchener (see Bibliography below), p. 199.
3. Casey (see Bibliography below), p. 41.
4. Maurice Merleau-Ponty, The Visible and the Invisible (Evanston: Northwestern University Press, 1968), p. 262.

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Moving Together in Improvisational Dance: An Empirical Phenomenological Study

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In this paper, I would like to illustrate a way of exploring movement in an empirical phenomenological manner. The particular phenomenon I will use is that of two dancers moving together in an improvisational dance. The method and findings I will present are taken from a previous study reflecting my psychological interests (Levi, 1978). Before getting into the method and findings, I will sketch out what I mean by a phenomenological approach to movement and why, as a psychologist, I felt compelled to take it.

The Phenomenological Approach

Phenomenology began as a method of philosophical inquiry at the turn of the century. It has developed into a small but growing movement within and across the social sciences. Phenomenologists understand this as a response to the "crisis of our times." This crisis can be characterized as the inability of science conceived as natural science, to solve critical life problems. The natural sciences have contributed to the problems of the day by not taking up and including the question of human values nor weighing the meaning of existence in their quest for knowledge. The social sciences, having borrowed the methods of natural science to legitimate their existence, have contributed to this crisis by not finding hoped for solutions. The phenomenological movement has sought to reformulate the social sciences as human sciences, to approach critical life problems and the experiences of everyday life as they are lived, in the quest for knowledge that is useful in helping us to understand the situation in which we find ourselves.

Natural science has approached persons as objects of inquiry, as if they were no different from the things of the world. Excluded by this approach is the sense of persons as the source and creators of scientific inquiry; that is, the subjective side of persons. This has resulted in our having a distorted view of ourselves, one which excludes our sense of ourselves as agents in the world, as meaning-givers, as bearers of values, as the ones for whom the facts we collect about ourselves are meaningful. Phenomenology seeks to develop rigorous and systematic methods that will include our subjectivity even when we are the objects of study (Giorgi, 1970).

From a phenomenological perspective, our sense of ourselves as subjects and as objects are not mutually exclusive categories, as natural science leads us to believe, but two ways we experience ourselves in the world with others. Phenomenology asks us to take our experience seriously. This means approaching experience not as the by-product of a neuro-physiological chain of events triggered by random interactions in the physico-chemical world, but as the fundamental ground of our knowledge. Experience is not merely something that happens to us; it is intentional. This means, among

other things, that experience always refers beyond itself to a situation; our experience is situated. The experience of being-in-a-situation, for a person, is structured by temporal, spatial, and social horizons of that experience. These horizons are contexts of meaning. A study of lived experience, therefore, is the means by which we can understand other people and what things mean to them.

As a phenomenological psychologist, I am committed to exploring human experience as it is lived everyday. I recognize that a person is an experiencing being, whose consciousness of his relating to a particular situation gives meaning to this experience. When I say that experience is situated I also imply that experience is embodied. It is through his body that a person is tied to situations, to others, and ultimately to the world. The lived-body (Merleau-Ponty, 1962), conceived phenomenologically, is not the psysiological organism that natural science studies. It is an agent body, the body experienced by the person who acts in and with that body.

Movements of the body, then, are imbued with consciousness. Approaching human movement as a physical formation, i.e., considering it to be determined by natural forces outside of one's experience, as natural science would like us to believe, is, thus, secondary to an understanding of movement as intentional. When I say that movement is intentional I do not mean that a person is reflectively aware of, or knows in advance every move he makes. On the contrary, his moving is often prereflective. A person is not aware of all the meanings his movements may convey to others.

A study of movements as they are lived implies an inquiry into the meaning of movements. Taken as intentional formations, movements express the relationship of a person to his world, to others, and even to himself. They are visible tracings of his experience. As a phenomenological psychologist, I want to understand what a person intends (conscious or otherwise) through his moving, what it refers to, what it traces out. When I understand the intentional structure of a person's movements I learn what it means for him to be in the particular situation or relationship in which he finds himself.

An Empirical Phenomenological Study of Movement

I will now illustrate the method and findings of my empirical phenomenological study of movement. The phenomenon I used was "moving together in improvisational dance." This phenomenon refers to those moments in an improvisational situation where dancers appear to move together in a fluid, cohesive manner as if dancing an unwritten choreography. Because of the limitations of space, I can describe the method in only the briefest form and will omit entirely the steps involved in the phenomenological analysis. For those of you who might become intrigued with empirical phenomenological methods, I refer you to the works of Giorgi Fischer, Murray (1975); Colaizzi (1973); Keen (1975); and Levi (1978).

After I grouped four dance students into two couples, I asked each couple to improvise a dance together to a musical soundtrack. The soundtrack was made up of five short segments of different

kinds of music. These were jazz, environmental sounds, tribal drums, classical, and electronic.

Each couple was videotaped. Initially, I looked at each videotape for dance sequences where the dancers were moving well together. My criterion for identifying moments when the dancers appeared to be moving well together was when I saw their gestures adhere to one another. Such a sequence I labelled a coherence of gestures, which gestalted against the background of, for example, hesitant, awkward, fumbling movements.

I reduced the videotapes to ten short episodes (five for each couple, representing each of the musical situations) in which the couples' gestures appeared to cohere. In this way, I could study moving together in the improvisational dancing of two different couples across the same five musical situations.

Next, I interviewed each dancer separately while watching the videotape of his/her dancing, asking the dancers to describe their experience of the sequences where their gestures appeared to cohere. I indexed the dancers' protocols to the videotapes so that I could compare and contrast the dance partners' experiences within the same episodes of the dance.

Finally, informed by the dancers' experience I described and analyzed the gestural relating of each couple as they moved together through each of the indentified episodes. Thus, my access to the phenomenon of moving together was twofold. I analyzed the dancers, descriptions of their experience of moving together, getting an "internal" viewpoint anchored in concrete, publicly observable episodes. And, I used descriptions of my own perceptual experience, representing an "external" viewpoint of the phenomenon as it appeared to me in each of the episodes.

The idea, from a phenomenological frame of reference, was to explore and describe a sequence of movements, in this case, moving together, as a whole,as a way of access to its principle of organization or intentionality.

Empirical Findings

Again, due to spatial limitations, I can present my findings in only the briefest fashion. The dancers described moving together as "just being ourselves together", more like a blossoming forth of gestures rather than as a series of manipulated linear responses.

In order to create a dance out of their gestural relating, dancers surrendered their conscious egos in order to become "body-subjects" (Merleau-Ponty, 1962), in a sense lending their bodies to each other and allowing themselves to be taken by the pre-reflective movements of their bodies. The primary relationship between the dancers, during these moments when they were moving well together I characterized as "intercorporeal" (Merleau-Ponty, 1968), and only secondarily as interpersonal. This highlighted the fact that dancers were able to incorporate conflicting personal intentions in fluid sequences of spontaneous gestures indicating that as a couple they were expressing a complex relationship layered with meaning. Though the bodily feel of the movements was described similarly by the dance partners, they often ascribed divergent personal meanings to those shared experiences. Moving together was not a simple union of self and

other, but a highly variegated oneness. Relating at an intercorporeal level, dancers moved prereflectively, i.e., they didn't think out their or their partner's movements, nor screened their feelings.

Most of this and more was visible from an observer's stance as my analysis of the descriptions of my perceptual experience revealed. I found that each couple had a basically invariant, affectively textured, temporal configuration of gestures whose intercorporeally generated intentionality expressed the personal and interpersonal meaning of the couple's relationship. I will illustrate how this structure was concretely lived out by describing the style of each couples dancing. The style is that which remains the same in the variations of moving together each episode presents.

Couple A's (David, a male, and Mary, a female) gestures cohered to one another when they began to move in up, out, in, and down directions, changing levels and creating lines of force that were directed along diagonal axes. The affective texture of their spiralling, intertwining movements was often sensual and erotic, though it ranged from being tender and caring to being lyrical and romantic. Their courting relationship was visible in this intertwining of bodies, the stretching of limbs along diagonal axes, and the undulations in the couple's turns created by the up, out, in, and down configuration of gestures.

In terms of their interpersonal significance, David's outward and upward gestures often appeared as invitations for Mary to come out of her introspective shell, visible in her sometimes downward and inwardly directed postures which, at times, seemed to express disappointment. In this way, she was often brought out of her shell and lifted into the celebration of the dance. David's dominant expansive gestures were temptered by Mary's less powerful downward and inward directed gestures which created intimate spaces. It was as if Mary was trying to keep David grounded and with her as she began to give herself to him, though often the coherence would break as David's uplifting and expansive gestures, and independent spirit became too much for Mary. He would then continue on his own, with Mary falling back into herself, or he would come back to reinstate their relationship.

Gestural configurations then, are not merely physical patterns, but intentional forms. In this case they express a relationship that has its ups and downs, its invitations, and experiences of being left out. The personal meaning of the relationship for Mary, who "saw" romantic possibilities in relating, was not David's sense of it. In fact, the affective texture of tender sexuality that both dancers experienced revealed a relationship that ranged from secure friendship to romance.

In contrast, couple B's (Chris and Ann, two females) gestures cohered to one another when they began to move in some configuration of back and forth, and side to side directions, facing each other along the same horizontal axes, creating lines of force (often oppositional)along those axes. The affective texture of this configuration was often of aggressive, feisty, yet playful lunging, darting movements. They threw abrupt gestures at each other, like quick spins and parrying movements revealing a relationship that was competitive yet remained friendly.

Visible in these often explosive coherences was a continuing interpersonal battle for control and equality in the dance relationship. Chris most often appeared in control of the dance with her cool cat-like movements and teasing expressions. Ann, in order to cooperate, became the "fall guy" dancing Chris' dance until frustrated with the role, she challenged Chris for control. Ann's darting and lunging intrusions of Chris' space revealed this frustration and challenge, and served to keep Chris off balance some of the time, undercutting her domination.

Moving together in improvisational dance is not the result of individual conscious acts. Rather, the coherence of dancers gestures expresses a more fundamental intentionality, one generated intercorporeally. This fundamental intentionality refers to the meanings (conscious or otherwise) of the dancers' relationship as it is lived by them. I have tried to illustrate that the explication of such meanings is possible through an empirical phenomenological study of movement, and can tell us in general and specific terms what it means for persons to be in the particular relationship in which they find themselves.

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